



ENVIS CENTER

on

ENVIRONMENTAL BIOTECHNOLOGY

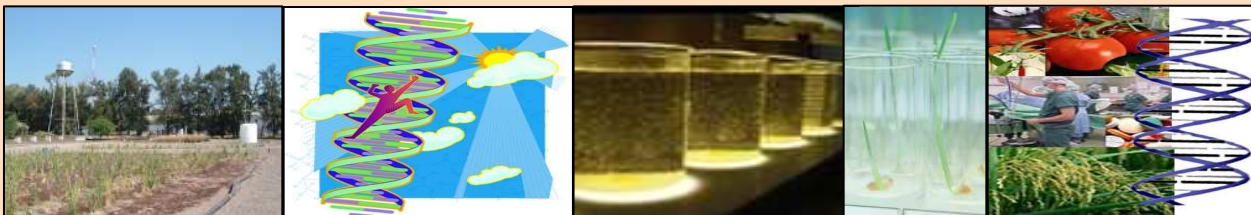
Abstract Vol. XI

Sponsored by

**MINISTRY OF ENVIRONMENT AND FOREST
GOVERNMENT OF INDIA
NEW DELHI**

**Department of Environmental Science
University of Kalyani
Nadia, West Bengal**

December 2007



Published by:

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ENVIRONMENTAL BIOTECHNOLOGY

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BACKGROUND

Environmental Information System (ENVIS) is established in the year 1984 as a network of Information Centres. It is planned by the Ministry of Environment and Forest. Aim of this centre is to provide descriptive and environmental subject related numerical data. Now 78 centres are working under this network on various subject areas in the country. The focal point of this network is situated at the Ministry of Environment and Forest, Government of India, New Delhi.

This ENVIS Centre is established for studies on Environmental Biotechnology at the Department of Environmental Science, University of Kalyani, Nadia-741235, West Bengal.

The objective of this centre is to collect data related to the above mentioned subject, from different major libraries mainly in West Bengal and also from other states in India, through consultation with different journals, Annual Reviews, Internet and to generate a database and create a website uploaded with these information. Besides, we publish biannually Abstract Volume on our thematic area Environmental Biotechnology under fourteen subheads. The volume contains abstracts of scientific articles from relevant national and international journals. Viewpoint of this abstract volume is to help the interested research workers, scientists, administrators and the general people.

This is the 11th publication of Abstract Volume of this ENVIS Centre. This contains the abstracts of research papers collected in the area of Environmental Biotechnology from various journals published from July 2007 onwards. In this issue, various topics like Bioengineering, Bio-degradation, Bio-remediation, Bio-transformation etc. have been covered. We are grateful to the various libraries and their staff for their cooperation extended to us during the collection of the articles.

Abstract Format

The format of the abstract is as follows:

Abstract : The abstracts are arranged in different subheads.

Author: Name of the authors are given in the order in which they appear in the original document. These names are given in succession.

Address of Authors: Address of the author is given in parenthesis at the end of the authors name. When the address of any other author is found, it is written after wards delimited by stop(.).

Locus: The name of the journal is followed by the volume number, issue number, year of publication and the page no.

GENERAL INFORMATION

Abstract have been taken directly from source documents like research report, journals, internet, seminar proceedings, standards and patents. All the resources are published within last six months.

Abstract are broadly classified and arranged under the following 14 heads:

Bioaccumulation: Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things whenever they are taken up and stored at a rate faster than they are broken down (metabolized) or excreted. Understanding the dynamic process of bioaccumulation is very important in protecting human beings and other organisms from the adverse effects of chemical exposure, and it has become a critical consideration in the regulation of chemicals.

Bioremediation: It is a clean-up technology that uses naturally occurring microorganisms to degrade hazardous substances into less toxic or nontoxic compounds. The microorganisms may:

1. Ingest and degrade organic substances as their food and energy source,
2. Degrade organic substances, such as chlorinated solvents or petroleum products, that are hazardous to living organisms, including humans, and degrade the organic contaminants into inert products.

As the microorganisms occur naturally in the environment they are likely to pose little risks of contamination.

Bio-Transformation: This is a process of Biological changes of complex compounds to simpler one or toxic to non-toxic and vice-versa. Several microorganisms are capable of transforming a variety of compounds found in nature but generally in case of synthetic compounds they are unable to show any appropriate action. Biotransfer appears to be one of the major detoxication methods known so far.

Biomarker: It is a biological response to a chemical that gives a measurement of exposure and, sometimes, of toxic effect. It can be defined as any kind of molecule which indicate the existence (past or present) of living organisms. In particular, in the fields of geology and astrobiology biomarkers are also known as biosignatures. However, in environmental science a bio-markers can also be used to indicate exposure to various environmental substances in epidemiology and toxicology.

Biofertilizer: To reduce the impact of excess chemical fertilizers in the field of agriculture the biofertilizer is being considered as a potential tool; biologically fixed nitrogen is such a source which can supply an adequate amount of Nitrogen to plants and other nutrients to some extent. Many free living and symbiotic bacteria, which fix

atmospheric Nitrogen are used as biofertiliser material as a substitute for Nitrogen fertilizer. In general two types of biofertiliser are used

1. Bacterial Biofertilizer
2. Algal Biofertilizer

Biocomposting: It involves combining organic materials under conditions that enables them to decompose more quickly than they would in nature. Think about logs and leaves on the ground in a forest. The leaves will break down and disappear within a year. Logs of course will take much longer to crumble away. Composting is the process of converting all biodegradable wastes into organic manure. In composting process certain input should be made into waste to convert the process in a short time.

Biopesticide: Pest control by biological antagonism appears to be very useful tool in recent years. Bacterial pesticides are being developed. *Heliothis* complex, which lives in close association with plant roots, consists of two major crop pests budworm and ball worm. Biological insecticides against both these insects are being prepared by transfer of a gene from *Bacillus thuringiensis*

Biodegradation: It is nature's way of recycling wastes, breaking down organic matter into nutrients that can be used by other organisms. "Degradation" means decay, and the "bio-" prefix means that the decay is carried out by a huge assortment of bacteria, fungi, maggots, worms, and other organisms that eat dead material and recycle it into new forms.

In the nature, nothing is known as waste, because everything gets recycled. The waste products from one organism become the food for others, providing nutrients and energy while breaking down the waste organic matter. Some organic materials may break down much faster than others, but all will eventually decay.

By harnessing these natural forces of biodegradation, people can reduce wastes and clean up some types of environmental contaminants. Through **composting**, we accelerate natural biodegradation and convert organic wastes to a valuable resource.

Biosensor: Biosensor represents biophysical devices, which can detect the presence and measure the quantities of specific substances in a variety of environments. These specific substances may include sugars, proteins, or humas and variety of toxins in the industrial effluents. In designing a biosensor an enzyme or an antibody or even microbial cells are associated with microchip devices, which are used for quantitative estimate of a substance.

Bioengineering: It is a developing speciality featuring a multidisciplinary approach to the solution of problems in medicine and biology, based on the application of advances in science, engineering and technology. It generally engineers the biological processes through biotechnological or genetic engineering

interventions. It may also be a broad-based engineering discipline that involve product design, sustainability and analysis of biological systems.

Pollen-Biotechnology: This is a new field of science dealing with the pollen chemistry and allergenicity of aerospora. This subject also covers genetic manipulation of pollen development of haploid culture. Such haploid plants have immense values in genetic research.

Biotechnology Policy Issue: Biotechnology appears to be an emerging science in present decades. Genetic manipulation and development of genetically modified organism in human welfare is now showed a potential prospect and risk. Thus, researches and application of Biotechnology in diverse field is a major policy issue in the present decades.

Agricultural Biotechnology: Over the years, tremendous success has been made in diverse field of agriculture by applying Biotechnology. It includes development of genetically modified crops, genetic improvement in sericulture practices, improvement in Biofertilizer development and similar other aspects. Production of pest and disease resistant crop is also being considered to be an emerging area of Agricultural Biotechnology.

Bioenergy: In recent decades, efforts have been made for evolving were non-polluting bioenergy sources or energy generation from organic wastes and biomass. These are all ecofriendly solutions. Biomass energy supply-demand balances have become a component of energy sector analysis and planning and is propelled huge importance in the countries. Biomass, Biogas, Hydrogen are the example of Bioenergy.

ABBREVIATIONS USED IN ADDRESSES AND CITED JOURNALS

Acad	Academy	Chem	Chemistry
Adm	Administration	Cheml	Chemical
Admn	Administrative	Clinl	Clinical
Adv	Advance	Co	Company
Agri	Agriculture	Coll	College
Agricl	Agricultural	Comm	Committee
Amer	American	Commn	Commission
An	Annual	Comp	Comparative
Analyt	Analytical	Conf	Conference
Anat	Anatomy	Conv	Convention
Anim	Animal	Conserv	Conservation
Ann	Annals	Contl	Control
Appl	Applied	Contam	Contamination
Arch	Archives	Corp	Corporation
Archaeo	Archaeology	Coun	Council
Archaeol	Archaeological	Cult	Culture
Architect	Architecture	Cultl	Cultural
Assoc	Association	Curr	Current
Asst	Assistant	Dept	Department
Atom	Atomic	Dev	Development
Bacterio	Bacteriology	Develop	Developmental
Bacteriol	Bacteriological	Dig	Digest
Bd	Board	Div	Division
Bio	Biology	Divl	Divisional
Biochem	Biochemistry	Dte	Directorate
Biocheml	Biochemical	Dy	Deputy
Bioengg	Bioengineering	Eco	Ecology
Biol	Biological	Ecol	Ecological
Biometeo	Biometeorology	Econ	Economics
Biophys	Biophysics	Ecosys	Ecosystem
Biometeol	Biometeorological	Ecotoxic	Ecotoxicology
Biotech	Biotechnology(s)	Endocrinol	Endocrinological
Biotechno	Biotechnology	Engg	Engineering
Biotechnol	Biotechnological	Engrs	Engineers
Bldg	Building	Env	Environment
Bot	Botany	Environ	Environmental
Botl	Botanical	Epidemic	Epidemiology
Br	Branch	Epidemiol	Epidemiological
Bull	Bulletin	Estd	Establishment
Cent	Centre	Ethnopharmac	Ethnopharmacology
Centl	Central	Expt	Experiment

Exptl	Experimental	Microbiol	Microbiological
Fac	Faculty	Min	Ministry
Fd	Food	Monit	Monitoring
Fedn	Federation	Myco	Mycology
Fert	Fertiliser	Mycol	Mycological
Fmg	Farming	Nat	Natural
Gaz	Gazette	Natl	National
Genet	Genetics	N-E	North Eastern
Geo	Geology	Nut	Nutrition
Geogr	Geography	No	Number
Geogr1	Geographical	Occ	Occasional
Geol	Geological	Occupl	Occupational
Geosci	Geoscience	Oceanogr	Oceanography
Govt	Government	Org	Original
Hist	History	Orgc	Organic
Hlth	Health	Orgn	Organisation
Hort	Horticulture	Pharmaco	Pharmacology
Hosp	Hospital	Pharmacol	Pharmacological
Hydro	Hydrology	Phyl	Physical
Hydrol	Hydrological	Patho	Pathology
Immuno	Immunology	Pathol	Pathological
Immunol	Immunological	Petrochem	Petrochemical
Ind	Industry	Petro	Petrology
Inf	Information	PG	Post Graduate
Inst	Institute	Phys	Physics
Instn	Institution	Physio	Physiology
Int	International	Phytopath	Phytopathology
Irrig	Irrigation	Phytopathol	Phytopathological
J	Journal	Plang	Planning
Lab	Laboratory	Polln	Pollution
Lett	Letter(s)	Proc	Proceedings
Ltd	Limited	Prot	Protection
Malario	Malariology	Pub	Publication
Malariol	Malariological	Pvt	Private
Manag	Management	Qlty	Quality
Med	Medicine	Qr	Quarter
Medl	Medical	Rad	Radiation
Metab	Metabolism	Radio	Radiology
Metall	Metallurgy	Radiol	Radiological
Metallurg	Metallurgical	Rd	Road
Meteo	Meteorology	Recd	Received
Meteol	Meteorological	Reg	Region
Microbio	Microbiology	Regl	Regional

Rep	Report	Surv	Survey
Reptr	Reporter	Syst	System
Res	Research	Tax	Taxonomy
Rev	Review	Techl	Technical
Sch	School(s)	Techno	Technology
Sci	Sciences(s)	Technol	Technological
Scient	Scientific	Toxico	Toxicology
S-E	South East	Toxicol	Toxicological
Sec	Section	Transc	Transcations
Sect	Sector	Transpt	Transportation
Semin	Seminar	Trng	Training
Ser	Services	Trop	Tropical
Soc	Society	Univ	University
Socl	Social	Util	Utilisation
Stat	Statistics	Vet	Veterinary
Statl	Statistical	Zoo	Zoology
Stnd	Standard(s)	Zool	Zoological
Stud	Study/ (eis)		

Bioaccumulation

Shalini Sharma^{1, 2}. (¹Environment, B. Ana Labs, Road No.10, Banjara Hills, Hyderabad, AP, 500 034, India, ² National Botanical Research Institute, Lucknow, 226 001, UP, India, Corresponding author: Shalini Sharma, Email: shashalini@gmail.com). *Marchantia polymorpha* L.: A Bioaccumulator. *Aerobiologia*, Volume 23, (3)(2007): 181-187.

Mussoorie in the western Himalayas of India, a popular tourist destination, was selected for air pollution monitoring. The study was carried out applying thalloid liverwort species *Marchantia polymorpha* L. as a tool. Moss bags containing *M. polymorpha* was transplanted at residential, highly and less polluted areas to obtain comprehensive and comparative data. Lead content, along with some essential micronutrients viz. zinc, manganese, and copper, as well as some physiological parameters total chlorophyll, sugar, protein, catalase and peroxidase activity were analyzed. The highest accumulation of lead (Pb) in *M. polymorpha* plants was highest in summer season, i.e., 2276 µg/g dry weight. The correlation of metals and physiological parameters has been made to get clear view of the effects of lead on physiology and essential micronutrients.

Keywords Bioaccumulator - Heavy metals - *Marchantia polymorpha* - Physiology - Vehicular pollution

Stanislav Vinopal^a, Tomas Ruml^a and Pavel Kotrba^a. (^aDepartment of Biochemistry and Microbiology, Institute of Chemical Technology, Technická 3, 166 28 Prague, Czech Republic. Corresponding author. Tel.: +420 220445134; fax: +420 220445167). Biosorption of Cd²⁺ and Zn²⁺ by cell surface-engineered *Saccharomyces cerevisiae*. *International Biodeterioration & Biodegradation*, Volume 60(2) (2007): 96-102

The carboxyl-terminal part of sexual adhesion glycoprotein α -agglutinin (AG α 1Cp) was employed as an anchoring domain for surface display of short metal binding peptides of sequences N-Ser-(Gly-Cys-Gly-Cys-Pro-Cys-Gly-Cys)₂-Gly-C (CP2 peptide) and N-Ser-(Gly-His-His-Pro-His)₃-Gly-C (HP3 peptide) in the cell wall of potential biosorbent *Saccharomyces cerevisiae*. The constructed genetic fusions were efficiently expressed and found covalently attached to cell wall glucan and both O- and N-glycosylated. As a consequence of AG α 1Cp overexpression the nitrogen content of cell wall increased by 30%, which was reflected by increased sorption capacity of both isolated cell walls and intact cells. Compared to parental cells, the surface display of mere anchoring domain doubled the amount of Cd²⁺ and Zn²⁺ adsorbed by modified biomass from solutions containing 10 to 200 µM metal ions. Displayed CP2 and HP3 sequences showed selectivity towards Cd²⁺ and Zn²⁺, respectively. The fusion of CP2 peptide to AG α 1Cp sequence increased Cd²⁺ sorption by 30%, whilst accumulation of Zn²⁺ remained unaffected. The HP3 sequence, shown to form 3 high-affinity Zn²⁺ binding sites with apparent dissociation constant of 1.2×10⁻⁷, increased capability of engineered strain to adsorb Zn²⁺ by 20% but did not contribute to Cd²⁺ sorption. The Scatchard analysis of metal adsorption data suggest that the expression of AG α 1Cp variants in *S. cerevisiae* increased the number of high-affinity covalent ligand-metal interactions, thereby enhancing metal recovery at low external concentrations. In addition, glycosylation of anchoring domain by polymannans, presumably phosphorylated, was likely to increase the ion-exchange capacity of modified biosorbent, which became effective at higher metal concentrations.

Keywords: Yeast biosorbent; α -agglutinin; Cell surface display; Metal-binding peptide

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It is hypothesized that metal hyperaccumulator plants have specific rhizosphere conditions, potentially modifying the bioavailability of soil metals. This article aims to further the knowledge about the rhizosphere of the hyperaccumulator *Thlaspi caerulescens*, focusing on its microflora isolated from metalliferous soils collected *in situ* where the plants grow naturally. We characterized the cultivable microbial communities isolated from the rhizosphere of one population of this Ni hyperaccumulator species grown on a serpentine soil. The rhizosphere soil harbored a wide variety of microorganisms, predominantly bacteria, confirming the stimulatory effect of the *T. caerulescens* rhizosphere on microbial growth and proliferation. We tested the hypothesis that the rhizosphere of *T. caerulescens* influences 1) the metabolic diversity of the bacterial community and 2) the bacterial resistance to metals. The principal component analysis of the Biolog[®] plate's data confirmed a structural effect of the rhizosphere of *T. caerulescens* on bacterial communities. The percentage of Ni-resistant bacteria was higher in the rhizosphere than in the bulk soil, suggesting a direct effect of the rhizosphere on Ni tolerance, reflecting a greater bacterial tolerance to Ni in the rhizosphere.

Keywords: rhizosphere; metal hyperaccumulators; *Thlaspi caerulescens*; microbial diversity; metal resistance; phytoextraction

Behnaz Saffar^{1, 2, 3}, Bagher Yakhchali¹ and Mehdi Arbabi¹. (¹National Institute of Genetic Engineering and Biotechnology (NIGEB), Tehran, Iran, ²Biology Department, Faculty of Science, Razi University, Kermanshah, Iran, ³Biology Department, Faculty of Science, Shahrkord University, Shahrkord, Iran. Bagher Yakhchali, Email: bahar@nigeb.ac.ir). Development of Bacterial Surface Display of Hexahistidine peptide using CS3 Pili for Bioaccumulation of Heavy Metals. *Current Microbiology*, Vol 55(4)(2007): 273-277.

A novel cell surface display system for metal uptake was developed using CS3 pili of enterotoxigenic *Escherichia coli*, which is a suitable system for display of heterologous peptides. The recombinant bacteria producing the hybrid pili containing the hexahistidine peptide accumulated high concentrations of Cd²⁺ and Ni²⁺ at 656.2 and 276.5 nmol per mg dry weight of bacterial cell, respectively. The recombinant bacteria may be useful in water and waste water treatment.

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anthropogenic contaminants by detritivorous fish in the Río de la Plata estuary: 1-Aliphatic hydrocarbons. Chemosphere, Volume 68(11) (2007): 2128-2135

The temporal variability and bioaccumulation dynamics of C₁₂₋₂₅ *n*-alkanes, isoprenoids and unresolved aliphatic hydrocarbons (UCM) were studied in a detritivorous fish (Sábalo: *Prochilodus lineatus*) collected from 1999 to 2005 in the sewage impacted Buenos Aires coastal area. Fish muscles contain huge amounts of *n*-C₁₂₋₂₅ (165 ± 93, 70 ± 48 or 280 ± 134 µg g⁻¹, dry, fresh and lipid weight, respectively) and UCM (931 ± 560, 399 ± 288 and 1567 ± 802 µg g⁻¹) reflecting the chronic bioaccumulation of fossil fuels from sewage particulates. On a temporal basis, lipid normalized aliphatic concentrations peaked by the end of 2001–2002 during the rainiest period over the last four decades (1750 vs. 1083 ± 4.6 mm in 1999, 2004 and 2005), reflecting an enhanced exposition due to massive anthropogenic fluxes from Metropolitan Buenos Aires in wet years. The hydrocarbon composition in fish muscles is enriched in *n*-C₁₅₋₁₇ and isoprenoids relative to a fresh crude oil and settling particulates, with fresher signatures during the 2001–2002 maxima. Fish/settling material bioaccumulation factors (BAFs: 0.4–6.4 dry weight or 0.07–0.94 lipid-organic carbon) plotted against *K*_{ow} showed a parabolic pattern maximizing at *n*-C₁₄₋₁₈ and isoprenoids. The optimal bioaccumulation window corresponds to highly hydrophobic (log *K*_{ow}: 7.2–9.9), intermediate-size C₁₄₋₁₈ *n*-alkanes and C₁₅₋₂₀ isoprenoids (MW: 198–282; length: 17.9 to 25.4 Å) with melting points ranging from –19.8 to 28 °C. The uptake efficiency is inversely correlated to melting points and increased from 75% for *n*-C₂₅ to above 90% for *n*-C₁₄₋₁₅ and isoprenoids.

Keywords: Sewage detritus; Hydrocarbons; Fish; Río de la Plata

Chen-Wuing Liu^a, Ching-Ping Liang^{a, b}, Kao-Hung Lin^c, Cheng-Shin Jang^d, Sheng-Wei Wang^a, Yung-Kay Huang^e and Yu-Mei Hsueh^f. (^aDepartment of Bioenvironmental Systems Engineering, National Taiwan University, Taipei 106, Taiwan, ROC, ^bDepartment of Environmental Engineering and Science, Foo-Yin University, Kaoshiung 831, Taiwan, ROC, ^cSustainable Environment Research Center, National Cheng Kung University, Tainan 701, Taiwan, ROC, ^dDepartment of Leisure and Recreation Management, Kainan University, Luzhu, Taoyuan, Taiwan 338, Republic of China, ^eGraduate Institute of Medical Sciences, Taipei Medical University, Taipei 110, Taiwan, ROC, ^fDepartment of Public Health, School of Medicine, Taipei Medical University, Taipei 110, Taiwan, ROC. Corresponding author. Tel.: +886 2 2362 6480; fax: +886 2 2363 9557.). **Bioaccumulation of arsenic compounds in aquacultural clams (*Meretrix lusoria*) and assessment of potential carcinogenic risks to human health by ingestion. Chemosphere, Volume 69(1) (2007): 128-134**

This study surveyed the total arsenic (As) and As species contents in clams (*Meretrix lusoria*) farmed in areas of hyperendemic blackfoot disease (BFD) in southwestern Taiwan. Total As and As species in sediment and pond water were also analyzed to examine the bioaccumulation of As in clams in their exposure environment. Moreover, potential carcinogenic risks associated with the ingestion of As in aquacultural clams were evaluated probabilistically. The average total As contents in medium-sized and small clams were 7.62 and 10.71 µg/g (dry wt), respectively. The content of the As species in this study was approximately 61% of the total As content. The other unquantified As species are possibly arsenocholine, arsenosugar and arsenolipid. The average ratios of inorganic As contents to total As contents in clams ranged from 12.3% to 14.0% which are much higher than that found in the farmed oyster (*Crassostrea gigas*), indicating that humans

may expose to larger quantities of inorganic As by ingesting the same amount of clam as oyster. Using different ingestion rates derived by the average consumption method and the questionnaire method, the estimated risks to human health associated with consuming clams from the BFD area ranging from slightly to largely exceed the standard target risk. Based on the estimation of the TR model, a 0.18 g/day-person of the safe ingestion rate of clams in the BFD region is recommended.

Keywords: Arsenic species; Blackfoot disease; Bioaccumulation; Clam; Risk

M. Azizur Rahman^a, H. Hasegawa^a, M. Mahfuzur Rahman^b, M. Arifur Rahman^c and M.A.M. Miah^d. (^aGraduate School of Natural Science and Technology, Kanazawa University, Kakuma, Kanazawa 920-1192, Japan, ^bDepartment of Botany, Jahangirnagar University, Savar, Dhaka 1342, Bangladesh, ^cBangladesh Centre for Advancement of Science (BCAS), Dhanmondi, Dhaka, Bangladesh, ^dBangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. Corresponding author. Tel./fax: +81 76 234 4792.). **Accumulation of arsenic in tissues of rice plant (*Oryza sativa* L.) and its distribution in fractions of rice grain. *Chemosphere*, Volume 69(6) (2007): 942-948**

A study was conducted to investigate the accumulation and distribution of arsenic in different fractions of rice grain (*Oryza sativa* L.) collected from arsenic affected area of Bangladesh. The agricultural soil of study area has become highly contaminated with arsenic due to the excessive use of arsenic-rich underground water ($0.070 \pm 0.006 \text{ mg l}^{-1}$, $n = 6$) for irrigation. Arsenic content in tissues of rice plant and in fractions of rice grain of two widely cultivated rice varieties, namely BRRI dhan28 and BRRI hybrid dhan1, were determined. Regardless of rice varieties, arsenic content was about 28- and 75-folds higher in root than that of shoot and raw rice grain, respectively. In fractions of parboiled and non-parboiled rice grain of both varieties, the order of arsenic concentrations was; rice hull > bran-polish > brown rice > raw rice > polish rice. Arsenic content was higher in non-parboiled rice grain than that of parboiled rice. Arsenic concentrations in parboiled and non-parboiled brown rice of BRRI dhan28 were 0.8 ± 0.1 and $0.5 \pm 0.0 \text{ mg kg}^{-1}$ dry weight, respectively while those of BRRI hybrid dhan1 were 0.8 ± 0.2 and $0.6 \pm 0.2 \text{ mg kg}^{-1}$ dry weight, respectively. However, parboiled and non-parboiled polish rice grain of BRRI dhan28 contained 0.4 ± 0.0 and $0.3 \pm 0.1 \text{ mg kg}^{-1}$ dry weight of arsenic, respectively while those of BRRI hybrid dhan1 contained 0.43 ± 0.01 and $0.5 \pm 0.0 \text{ mg kg}^{-1}$ dry weight, respectively. Both polish and brown rice are readily cooked for human consumption. The concentration of arsenic found in the present study is much lower than the permissible limit in rice (1.0 mg kg^{-1}) according to WHO recommendation. Thus, rice grown in soils of Bangladesh contaminated with arsenic of $14.5 \pm 0.1 \text{ mg kg}^{-1}$ could be considered safe for human consumption.

Keywords: Arsenic; Accumulation; Rice (*Oryza sativa* L.); Brown rice grain; Polish rice grain

Nur Koçberber^a and Gönül Dönmez^a. (^aAnkara University, Faculty of Science, Department of Biology, 06100 Beşevler, Ankara, Turkey. Corresponding author. Tel.: +90 312 2126720; fax: +90 312 2232395). **Chromium(VI) bioaccumulation capacities of adapted mixed cultures isolated from industrial saline wastewaters. *Bioresource Technology*, Volume 98(11) (2007): 2178-2183**

Enrichment mixed cultures tolerating relatively high concentrations of chromium and salt ions were isolated and their bioaccumulation properties improved by adaptation. Mixed cultures were

enriched in Nutrient Broth media containing 25–300 mg l⁻¹ Cr(VI) and 0%, 2%, 4%, 6% (w/v) NaCl. Bioaccumulation of Cr(VI) was studied in a batch system as a function of initial pH (7, 8 and 9), Cr(VI) and NaCl concentrations. Increasing NaCl and Cr(VI) concentrations led to significant decreases in percentage uptake and dried weight of mixed cultures but increased maximum specific chromium uptake. The maximum specific chromium uptake value at pH 8 was 58.9 mg g⁻¹ for 316.1 mg l⁻¹ Cr(VI) in the absence of NaCl, while at pH 9 it was 130.1 mg g⁻¹ in media including 194.5 mg l⁻¹ Cr(VI) and 2% NaCl concentrations. At 4% NaCl, the maximum Cr(VI) uptake of 127.0 mg g⁻¹ for 221.1 mg l⁻¹ Cr(VI) occurred at pH 9, while at 6% NaCl the maximum Cr(VI) uptake of 114.9 mg g⁻¹ for 278.1 mg l⁻¹ Cr(VI) was found at pH 7.

Keywords: Bioaccumulation; Chromium(VI); Microorganism; Saline wastewater

Xu Han^a, Yuk Shan Wong^b, Ming Hung Wong^c and Nora Fung Yee Tam^a. (^aDepartment of Biology and Chemistry, City University of Hong Kong, Kowloon, Hong Kong, China, ^bDepartment of Biology, Hong Kong University of Science and Technology, Kowloon, Hong Kong, China, ^cCroucher Institute of Environmental Sciences, Hong Kong Baptist University, Kowloon, Hong Kong, China. Corresponding author. Tel.: +852 27887793; fax: +852 27887406). **Biosorption and bioreduction of Cr(VI) by a microalgal isolate, *Chlorella miniata*. Journal of Hazardous Materials, Volume 146(1-2) (2007): 65-72**

The ability and mechanism of a microalgal isolate, *Chlorella miniata* to remove Cr(VI) were investigated. Kinetic studies indicated that both biosorption and bioreduction were involved in the Cr(VI) removal. The adsorbed Cr(VI) was reduced to Cr(III), and desorption studies indicated that Cr(III) occupied most of the adsorption sites on the biomass. The equilibrium time for Cr(VI) removal was dependent on various factors including initial pH, biomass and Cr(VI) concentrations. Equilibrium study showed that the Cr(VI) removal capacity was negatively related to the initial pH, and the biosorption capacity of total Cr [Cr(III) and Cr(VI)] reached the maximum at initial pH of 3.0. The spectrum of Fourier Transform Infrared Spectrometer analysis (FTIR) further confirmed that amino group on the algal biomass was the main adsorption site for Cr(VI) biosorption in acidic pH while the reduced Cr(III) was mainly sequestered by carboxylate group. The comparison between biosorption–bioreduction and direct bioreduction kinetic models proved that biosorption of Cr(VI) was the first step, followed by Cr(VI) bioreduction and Cr(III) biosorption on the algal biomass.

Keywords: Algae; Biosorption; Hexavalent chromium; Trivalent chromium; Bioreduction

Ahmadun Fakhru'l-Razi^a and Abul Hossain Molla^{a, b}. (^aDepartment of Chemical and Environmental Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor DE, Malaysia, ^bDepartment of Crop Botany, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur 1706, Bangladesh. Corresponding author: Department of Crop Botany, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur 1706, Bangladesh. Tel.: +880 2 9205310; fax: +880 2 9205333). **Enhancement of bioseparation and dewaterability of domestic wastewater sludge by fungal treated dewatered sludge. Journal of Hazardous Materials, Volume 147(1-2) (2007): 350-356**

A promising biological, sustainable, non-hazardous, safe and environmental friendly management and disposal technique of domestic wastewater sludge is global expectation. Fungal

entrapped biosolids as a result of prior fungal treated raw wastewater sludge was recycled to evaluate its performance as inoculum for bioseparation/bioconversion of supplemented sludge in view of continuous as well as scale up wastewater sludge treatment. Encouraging results were achieved in bioseparation of suspended solids and in dewaterability/filterability of treated domestic wastewater sludge. Fungal entrapped biosolids offered 98% removal of total suspended solids (TSS) in supplemented sludge treatment at 6-day without nutrient (wheat flour, WF) supply. Consequently, 99% removal of turbidity and 87% removal of chemical oxygen demand (COD) were achieved in supernatant of treated sludge. The lowest value (1.75×10^{12} m/kg) of specific resistance to filtration (SRF) was observed at 6-day after treatment, which was equivalent to the 70% decrease of SRF. The all results except SRF were not influenced further in treatments accompanied with WF supplementation. The present treatments offered significant ($P \leq 0.01$) improvement in all results except SRF of treated wastewater sludge compared to the control. Furthermore, the present result is addressing a potential avenue of probable solution for expected management and disposal of domestic wastewater sludge in future.

Keywords: Bioseparation; Dewaterability; Fungal entrapped biosolids; Domestic wastewater sludge

Kamra Anjana^a, Anubha Kaushik^a, Bala Kiran^a and Rani Nisha^a. (^aDepartment of Environmental Science and Engineering, Guru Jambheshwar University of Science and Technology, Hisar-125 001, India. Corresponding author. Tel.: +91 1662 263153; fax: +91 1662 276240). **Biosorption of Cr(VI) by immobilized biomass of two indigenous strains of cyanobacteria isolated from metal contaminated soil. Journal of Hazardous Materials, Volume 148(1-2) (2007): 383-386**

Biosorption of Cr(VI) using native strains of cyanobacteria from metal contaminated soil in the premises of textile mill has been reported in this paper. Biosorption was studied as a function of pH (1–5), contact time (5–180 min) and initial chromium ion concentration (5–20 mg/l) to find out the maximum biosorption capacity of alginate immobilized *Nostoc calcicola* HH-12 and *Chroococcus* sp. HH-11. The optimum conditions for Cr(VI) biosorption are almost same for the two strains (pH 3–4, contact time 30 min and initial chromium concentration of 20 mg/l) however, the biomass of *Chroococcus* sp. HH-11 was found to be more suitable for the development of an efficient biosorbent for the removal of Cr(VI) from wastewater, as it showed higher values of q_m and K_f , the Langmuir and Freundlich isotherm parameters. Both the isotherm models were suitable for describing the biosorption of Cr(VI) by the cyanobacterial biosorbents.

Keywords: Algae; Heavy metal; Adsorption isotherm

Joseph Y. Farah^a, Nour Sh. El-Gendy^b and Laila A. Farahat^b. (^aNational Research Center, El-Doki, Giza, Egypt, ^bEgyptian Petroleum Research Institute (EPRI), Nasr City, Cairo, Egypt. Corresponding author. Tel.: +202 274 7917; fax: +202 274 7433). **Biosorption of Atrazine Blue basic dye from an aqueous solution using dried biomass of Baker's yeast. Journal of Hazardous Materials, Volume 148(1-2) (2007): 402-408**

In this study dried biomass of Baker's yeast, *Saccharomyces cerevisiae*, is used as a sorbent for Atrazine Blue basic dye aqueous solution.

Factors affecting the adsorption process: dye concentration, contact time, temperature and pH were investigated. The equilibrium concentration and the adsorption capacity at equilibrium

were determined using three different sorption models namely: Langmuir, Freundlich and Temkin isotherms. It was found that increasing temperature and pH result in higher dye loadings per unit weight of the sorbent. The results gained from this study were described by Langmuir isotherm model better than Freundlich and Temkin isotherm models. The calculated heat of adsorption of the dye–yeast system indicates that the bio-sorption process is taking place by chemical adsorption and has an endothermic nature. The maximum adsorption capacity at 30 °C and pH 7 was calculated as 70 mg/g for dried biomass of Baker's yeast compared to 18.5 mg/g for commercial granular activated carbon, indicating that dried biomass of Baker's yeast can be considered as a good sorbent material for Astrazone Blue solution.

Keywords: Biosorption; Astrazone Blue; Basic dye; Baker's yeast; Isotherm models; Error analysis

Nomenclature

a_L : Langmuir isotherm constant (L/mg)

A : Temkin constant (L/g)

A_c : Clausius–Clapeyron constant

B : Temkin constant

C_o : initial liquid-phase concentration (mg/L)

C_e : equilibrium liquid-phase concentration (mg/L)

ΔH : heat of adsorption (cal/mol)

K_f : Freundlich isotherm constant (L/g)

K_L : Langmuir isotherm constant (L/g)

M : mass of adsorbent (g)

n : Freundlich isotherm constant

N : number of isotherm parameters

P : number of data points

q_e : equilibrium solid-phase concentration (mg/g)

q_{ecal} : calculated equilibrium solid-phase concentration (mg/g)

$q_{max\ exp}$: experimental maximum adsorption capacity (mg/g)

$q_{max\ theo}$: theoretical maximum adsorption capacity (mg/g)

R : universal gas constant (cal/mol K)

R_L : dimensionless constant separation factor

T : absolute temperature (K)

V : liquid-phase volume (L)

Mehmet Dogru^a, Reyhan Gul-Guven^b and Sait Erdogan^a. (^aDicle University, Faculty of Science, Chemistry Department, 21280 Diyarbakir, Turkey, ^bDicle University, Faculty of Science, Biology Department, 21280 Diyarbakir, Turkey. Corresponding author. Tel.: +90 412 2488550; fax: +90 412 2488300). **The use of *Bacillus subtilis* immobilized on Amberlite XAD-4 as a new biosorbent in trace metal determination. Journal of Hazardous Materials, Volume 149(1) (2007): 166-173**

The present work proposes the use of *Bacillus subtilis* immobilized on Amberlite XAD-4 as new biosorbent in trace metal determination. The procedure is based on the biosorption of Cu and Cd ions on a column of Amberlite XAD-4 resin loaded with dried, dead bacterial components prior to their determination by flame AAS. Various parameters such as pH, amount of adsorbent, eluent type and volume, flow rate of solution and matrix interference effect on the retention of the metal ions have been studied. The optimum pH values of quantitative sorption for Cu and Cd were found to be 7.0 and 7.5, respectively. These metal ions can be desorbed with 1 M HCl (recovery, 96–100%). The sorption capacity of the resin was 0.0297 and 0.035 mmol g⁻¹ for Cu²⁺ and Cd²⁺, respectively. The tolerance limit of some electrolytes were also studied. This procedure was applied to Cu²⁺ and Cd²⁺ determination in aqueous solutions, including river and well water systems. In order to evaluate the accuracy of the proposed procedure, the certified reference materials, NRCC-SLRS-4 Riverine water and LGC7162 Strawberry leaves were analyzed.

Keywords: *Bacillus subtilis*; Preconcentration; Amberlite XAD-4; Trace metal; Atomic absorption spectrometry

Santi Mohan Mandal, Keshab C Mondal, Satyahari Dey & Bikas Ranjan Pati. **Arsenic biosorption by mucilaginous seeds of *Hyptis suaveolens* (L.) Poit. Journal of Scientific & Industrial Research. Volume 66(7) (2007): 577**

Hyptis suaveolens seeds could serve as natural immobilized source of agriculturally based polysaccharide. Maximum adsorption capacity (6 g l⁻¹) of the seeds for arsenic adsorption has been found at pH 3.5 - 4.5. Among the tested interfering common metal ions, Ca⁺⁺, Mg⁺⁺ and Cl⁻ decreased adsorption rate about 48%, 54% and 30% respectively, whereas Zn⁺⁺ and Co⁺⁺ ions have no significant effect. Adsorption isotherm studies revealed a better correlation with Langmuir isotherm plot.

K Parvathi, R Nagendran & R Nareshkumar. **Effect of pH on chromium biosorption by chemically treated *Saccharomyces cerevisiae*. Journal of Scientific & Industrial Research, Volume 66(8) (2007): 675**

The effect of initial pH on biosorption by *Saccharomyces cerevisiae* of total chromium present in tannery effluent was investigated. Maximum biosorption efficiency was evident at neutral pH with a metal removal efficiency of 99 %. *S. cerevisiae* was then pretreated with NaOH and HCHO-HCOOH to study the role of proteins and amino acids, respectively, in biosorption. At pH 7, 9 and 11, biomass pretreated with NaOH exhibited significant biosorption as compared to raw biomass and that treated with HCHO-HCOOH. However, trend reversed at pH 2. At pH 4, untreated biomass exhibited maximum chromium sorption, when compared to that treated with NaOH and HCHO-HCOOH.

Fereydoon Malekzadeh¹, Saeid Ghorbanzadeh Mashkani², Hossein Ghafourian² and Mohammad Reza Soudi³. (¹Department of Microbiology, Faculty of Science, University of Tehran, Tehran, Iran, ²Department of Nuclear Biotechnology, Nuclear Research Center, Atomic Energy Organization of Iran, Tehran, Iran, ³Department of Microbiology, Faculty of Science, Alzahra University, Tehran, Iran. Fereydoon Malekzadeh, Email: falmero@yahoo.com) *World Journal of Microbiology and Biotechnology*, Volume 23(7) (2007): 905-910.

An attempt was made to isolate bacterial strains capable of biologically removing tungstate (WO_4^{2-}). Thirty-eight water samples were collected from various areas of Anzali lagoon, Iran. Initial screening of a total of 100 bacterial isolates at pH 5, resulted in the selection of one isolate with maximum adsorption capacity of 65.4 mg tungstate/g dry weight. It was tentatively identified as *Bacillus* sp. according to morphological and biochemical properties and named strain MGG-83. Tungsten concentration was measured spectrophotometrically using the dithiol method. Higher adsorption capacity was observed in the acidic pH ranging from 1 to 3. At pH 2, the strain removed 274.4 mg tungstate/g dry weight within 5 min from the solution with 300 mg WO_4^{2-} /l initial concentration and thereafter adsorption rate decreased remarkably. The applicability of the Freundlich isotherm for representation of the experimental data was investigated. Using 1 mM sodium azide and 10 mM 2,4-dinitrophenol, it was shown that only 20% reduction occurred in adsorption and steam sterilization of the bacterial cells resulted in 11% decrease in tungstate uptake. Temperature variations (20–40°C) had no significant effect on tungstate uptake. Pretreatment with the cations had no effect in uptake but pretreatment with anions decreased the tungstate uptake as indicated: sulfate > chromate > nitrate > molybdate > selenate > rhenate. Tungstate was removed from metal-laden biomass after desorption treatments by addition of different desorbing solutions with the results sodium acetate > EDTA > NaCl > KOH > H_2SO_4 .

Keywords Anzali lagoon - *Bacillus* sp. - Biosorption - Oxyanions - Tungstate

Xuefang Li¹, Wanzhi Wei¹, Xiandong Zeng¹, Jinxiang Zeng¹, Jian Yin¹ and Ling Wu¹. (¹State Key Laboratory of Chemo/Biosensing and Chemometrics, College of Chemistry and Chemical Engineering, Hunan University, Changsha, Hunan, 410082, P.R. China. Wanzhi Wei, Email: weiwz2003@126.com). Kinetic and equilibrium studies of copper biosorption onto *Pseudomonas aeruginosa* base using direct determination of copper by a voltammetric method. *World Journal of Microbiology and Biotechnology*, Volume 23(10) (2007): 1465-1471

This paper provided information on the use of linear sweep anodic stripping voltammetry for evaluating the process of copper biosorption onto *Pseudomonas aeruginosa*. This technique was suited to determine the concentration of free copper ion on site on the mercaptoethane sulfonate modified gold electrode surface without any pretreatment. It was in favor of the study of kinetic process as the fast changing kinetic data characteristic just after the beginning of biosorption could be accurately depicted. Based on the electrochemical results, the kinetics and equilibrium of biosorption were systematically examined. The pseudo-second-order kinetic model was used to correlate the kinetic experimental data and the kinetic parameters were evaluated. The Langmuir and Freundlich models were applied to describe the biosorption equilibrium. It was found that the Langmuir isotherm fitted the experimental data better than the Freundlich

isotherm. Maximum adsorption capacity of copper ion onto *Pseudomonas aeruginosa* was $0.9355 \mu\text{mol mg}^{-1}$ (about $59.4417 \text{ mg g}^{-1}$).

Keywords: Biosorption - Copper - Linear sweep anodic stripping voltammetry - Mercaptoethane sulfonate - *Pseudomonas aeruginosa*

Anjali Srivastava^a and Dipanjali Som^a. (^aNational Environmental Engineering Research Institute, Kolkata Zonal Centre i-8, Sector C, East Kolkata Area Development Project, P.O. East Kolkata Township, Kolkata 700107, India. Corresponding author. Tel.: +91 33 24415999; fax: +91 33 24421988). Hazardous air pollutants in industrial area of Mumbai – India. Chemosphere, Volume 69(3) (2007): 458-468

Hazardous Air Pollutants (HAPs) have a potential to be distributed into different component of environment with varying persistence. In the current study fourteen HAPs have been quantified in the air using TO-17 method in an industrial area of Mumbai. The distribution of these HAPs in different environmental compartments have been calculated using multi media mass balance model, TaPL3, along with long range transport potential and persistence. Results show that most of the target compounds partition mostly in air. Phenol and trifluralin, partition predominantly into soil while ethyl benzene and xylene partition predominantly into vegetation compartment. Naphthalene has the highest persistence followed by ethyl benzene, xylene and 1,1,1 trichloro ethane. Long range transport potential is maximum for 1,1,1 trichloroethane. Assessment of human health risk in terms of non-carcinogenic hazard and carcinogenic risk due to exposure to HAPs. have been estimated for industrial workers and residents in the study area considering all possible exposure routes using the output from TaPL3 model. The overall carcinogenic risk for residents and workers are estimated as high as unity along with very high hazard potential.

Keywords: VOCs; Multimedia model; Exposure risk; Hazard index; HAPs; Mumbai

P.Martin Deva Prasath and S.Kulathooran. (Department of Chemistry, TBML College, Porayar – 609 307, India Nagapattinam District, Tamil Nadu, India). Impact of Tsunami on the bioaccumulation of trace metals on the clam meretrix casta in vanjur estuary, karaikal, southeast coast of India. Pollution Research, Vol. 26 (2) (2007): 177-181.

Accumulation of trace of metals (Zn, Cu, Fe and Mn) in water, sediments and clam (Meretrix casta) at Vanjur estuary in Karaikal under the Union Territory of Pondicherry lying along the southeast coast of India were studied before and after Tsunami attack by using atomic absorption spectrophotometer. Accumulation of trace metals was observed in the order of Sediments> Clam> Water. In water, the order was found to be Mn > Fe > Zn > Cu; in sediments it was Mn > Fe > Cu > Zn and in bi-valve it was Fe > Zn > Mn > Cu. In water and bi-valve uniformly all the metals recorded higher values after tsunami. In sediments, Zn and Cu recorded higher values whereas Fe and Mn registered lower values after tsunami. Consequently, significant variations were observed in all the four trace metals studied after the tsunami.

Key words: Tsunami, Clam, Meretrix casta, trace metals, Vanjur, India.

Nilanjana Das, D. Charumathi, R. Vimala. (School of Biotechnology, Chemical and Biomedical Engineering VIT University, Vellore. Email: nilanjana00@lycos.com). An Evaluation of Cadmium (II) Biosorption - Mycelial Biomass of macrofungus *Pleurotus florida*. Environment: Science & Engineering, Vol. 5 (2) (2007).

A basic investigation into the removal of cadmium (II) ions from aqueous solutions by mycelial biomass of *Pleurotus florida* was conducted in batch conditions. The influence of different experimental parameters such as pH, biomass dosage, contact time and initial concentrations of metal ions on cadmium uptake were evaluated. Results indicated that with a pH of 5, a biomass concentration of 1g/L with one hour contact period and an initial metal ion concentration of 10 mg/L with one hour contact period and an initial metal ion concentration of 10 mg/L, mycelial biomass of *P. florida* could remove 50% cadmium (II) ions from aqueous solution. The Freundlich model better represented the sorption process, in comparison to the model of Langmuir. Preliminary data proved that *P. florida* can be used as a potent biomaterial for removal of cadmium ions from industrial effluents.

Bioremediation

Vincenza Andreoni¹ and Liliana Gianfreda². (¹Dipartimento di Scienze e Tecnologie Alimentari e Microbiologiche, Università degli Studi di Milano, Via Celoria 2, 20133 Milan, Italy, ²Dipartimento di Scienze del Suolo, della Pianta, dell'Ambiente e delle Produzioni Animali, Università di Napoli Federico II, Via Università 100, 80055 Portici, Napoli, Italy. Liliana Gianfreda, Email: liliana.gianfreda@unina.it). Bioremediation and monitoring of aromatic-polluted habitats. Applied Microbiology and Biotechnology, Volume 76(2) (2007): 287-308

Bioremediation may restore contaminated soils through the broad biodegradative capabilities evolved by microorganisms towards undesirable organic compounds. Understanding bioremediation and its effectiveness is rapidly advancing, bringing available molecular approaches for examining the presence and expression of the key genes involved in microbial processes. These methods are continuously improving and require further development and validation of primer- and probe-based analyses and expansion of databases for alternative microbial markers. Phylogenetic marker approaches provide tools to determine which organisms are present or generally active in a community; functional gene markers provide only information concerning the distribution or transcript levels (deoxyribonucleic acid [DNA]- or messenger ribonucleic acid [mRNA]-based approaches) of specific gene populations across environmental gradients. Stable isotope probing methods offer great potential to identify microorganisms that metabolize and assimilate specific substrates in environmental samples, incorporating usually a rare isotope (i.e., ¹³C) into their DNA and RNA. DNA and RNA in situ characterization allows the determination of the species actually involved in the processes being measured. DNA microarrays may analyze the expression of thousands of genes in a soil simultaneously. A global analysis of which genes are being expressed under various conditions in contaminated soils will reveal the metabolic status of microorganisms and indicate environmental modifications accelerating bioremediation.

Keywords: PAHs - BTEX - Bioremediation - Molecular approaches - Monitoring - Soil quality

Samuela Laconi¹, Giovanni Molle², Antonio Cabiddu² and Raffaello Pompei^{1,3}. (1Sezione di Microbiologia Applicata, Università di Cagliari, via Porcell 4, 09124 Cagliari, Italy, 2Istituto Zootecnico Casario di Sassari, Tutubella, Sassari, Italy, 3Biotecne, via Nuoro 58, 09125 Cagliari, Italy. Corresponding author: Raffaello Pompei, Email: rpompei@unica.it). Bioremediation of olive oil mill wastewater and production of microbial biomass. *Biodegradation*, Volume 18(5) (2007): 559-566.

Olive oil mill wastewater (OMWW) was used as a substrate for the culture of a mixture of edible fungi in order to obtain a potentially useful microbial biomass and to induce a partial bioremediation of this fastidious waste. Before fermentation, the OMWW underwent an alkaline-oxidative treatment with the aim of decreasing the polyphenolic content which is the main cause of its toxicity. The fungal mixture grew fairly well in the treated OMWW and reached a maximum of biomass production within about 14 days of fermentation at room temperature. Up to 150–160 g of wet biomass was obtained per liter of OMWW. Analysis of the partially dehydrated biomass revealed a protein content of about 13 g% and 6 g% of row fiber. A relevant presence of unsaturated fatty acids was found, as well as the presence of significant amounts of vitamins A and E, nicotinic acid, calcium, potassium and iron. The possibility of using the microbial biomass produced from OMWW as an additive to animal feed is discussed.

Keywords Biodegradation - Bioproteins - Microbial biomass - *Pleurotus* - Olive oil mill wastewater - Yeasts

Luis Rodriguez ^a; Jesusa Rincón ^a; Isaac Asencio ^a; Laura Rodríguez-Castellanos^a. (aDepartment of Chemical Engineering, Faculty of Environmental Sciences, University of Castilla-La Mancha, Toledo, Spain). Capability of Selected Crop Plants for Shoot Mercury Accumulation from Polluted Soils: Phytoremediation Perspectives. *International Journal of Phytoremediation*, Volume 9(1) (2007): 1 - 13

High-biomass crops can be considered as an alternative to hyperaccumulator plants to phytoremediate soils contaminated by heavy metals. In order to assess their practical capability for the absorption and accumulation of Hg in shoots, barley, white lupine, lentil, and chickpea were tested in pot experiments using several growth substrates. In the first experimental series, plants were grown in a mixture of vermiculite and perlite spiked with 8.35 $\mu\text{g g}^{-1}$ d.w. of soluble Hg. The mercury concentration of the plants' aerial tissues ranged from 1.51 to 5.13 $\mu\text{g g}^{-1}$ d.w. with lentil and lupine showing the highest values. In a second experiment carried out using a Hg-polluted soil (32.16 $\mu\text{g g}^{-1}$ d.w.) collected from a historical mining area (Almadén, Spain), the crop plants tested only reached shoot Hg concentration up to 1.13 $\mu\text{g g}^{-1}$ d.w. In the third experimental series, the Almadén soil was spiked with 1 $\mu\text{g g}^{-1}$ d.w. of soluble Hg; as a result, mercury concentrations in the plant shoots increased approximately 6 times for lupine, 5 times for chickpea, and 3.5 times for barley and lentil, with respect to those obtained with the original soil without Hg added. This marked difference was attributed to the low availability of Hg in the original Almadén soil and its subsequent increase in the Hg-spiked soil. The low mercury accumulation yields obtained for all plants do not make a successful decontamination of the Almadén soils possible by phytoremediation using crop plants. However, since the crops tested can effectively decrease the plant-available Hg level in this soil, their use could, to some extent, reduce the environmental risk of Hg pollution in the area.

Keywords: mercury availability; barley; lupine; chickpea; lentil; phytoextraction

C. W. Arnold^a; D. G. Parfitt^a; M. Kaltreider^b. (^a California Water Resources Control Board, Division of Water Quality, Sacramento, California, USA, ^bSolano County Department of Resource Management, Fairfield, California, USA). **Phytovolatilization of Oxygenated Gasoline-Impacted Groundwater at an Underground Storage Tank Site Via Conifers. International Journal of Phytoremediation, Volume 9(1) (2007): 53 - 69**

A stand of five conifers (*Pinus* sp.) bordering a gasoline service station was studied to estimate the methyl *tert*-butyl ether (MTBE) emission rate from gasoline-impacted groundwater. Groundwater was impacted with gasoline oxygenates MTBE and *tert*-butyl alcohol (TBA) at combined concentrations exceeding 200000 µg/L. Condensate from trees was collected in sealed environmental chambers and analyzed. Concentrations of MTBE in condensate ranged from 0.51 to 460 µg/L; TBA ranged from 12 to 4100 µg/L ($n = 19$). Transpirate concentrations were derived from MTBE air-liquid partitioning data exhibited in controls spiked with known concentrations of analyte. Tree emissions were estimated by multiplying average transpirate concentrations by transpiration rates derived from evapotranspiration data. Stand evapotranspiration was calculated using meteorological data from the California Irrigation Management Information System (CIMIS) applied in the Standardized Reference Evapotranspiration Equation.

Keywords: phytovolatilization; stand evapotranspiration; methyl *tert*-butyl ether (MTBE); *tert*-butyl alcohol (TBA); phytoattenuation

R. J. Ampiah-Bonney^a; J. F. Tyson^a; G. R. Lanza^b. (^a Department of Chemistry, University of Massachusetts, Amherst, Massachusetts, USA, ^bEnvironmental Sciences Program and Department of Microbiology, University of Massachusetts, Amherst, Massachusetts, USA). **Phytoextraction of Arsenic from Soil by *Leersia Oryzoides*. International Journal of Phytoremediation, Volume 9, Issue 1 January 2007, pages 31 – 40**

The potential of *Leersia oryzoides* (rice-cut grass) to remediate arsenic-contaminated soil was studied in greenhouse pot experiments. *Leersia oryzoides* grown in soil amended with arsenic to a concentration of 110 mg kg⁻¹, extracted up to 305 mg kg⁻¹ and 272 mg kg⁻¹ arsenic into its shoots and roots, respectively, giving a shoot:root quotient of 1.12 and phytoextraction coefficients up to 2.8. Plants in the arsenic-amended soil showed visible signs of stress in the first 8 wk of growth, but then recovered. Based on the 132 plants that were grown in a surface area of approximately 180 cm², the calculated total arsenic taken up by shoots is 120, 130, and 130 g ha⁻¹ at 6, 10, and 16 wk, respectively, suggesting that additional arsenic could be removed by periodic mowing over a growing season. Extraction with a mixture of nitric acid and hydrogen peroxide indicated that the available arsenic was constant after the first 6 wk. Uptake is comparable to that reported for duckweed (*Lemna gibba* L.) and overlaps the low end of the values reported for Chinese brake fern (*Pteris Vittata* L.)

Keywords: *Leersia oryzoides*; arsenic extraction; shoot:root quotient (SRQ); phytoextraction coefficient (PEC)

Naressa Cofield^a; A. Paul Schwab^b; M. Katherine Banks^a. (^a School of Civil Engineering, Purdue University, Lafayette, Indiana, USA, ^bSchool of Agronomy, Purdue University, Lafayette, Indiana, USA). **Phytoremediation of Polycyclic Aromatic Hydrocarbons in Soil: Part I. Dissipation of Target Contaminants. International Journal of Phytoremediation, Volume 9(5) (2007): 355 - 370**

Phytoremediation has been demonstrated to be a viable cleanup alternative for soils contaminated with petroleum products. This study evaluated the application of phytoremediation to soil from a manufactured gas plant (MGP) site with high concentrations of recalcitrant, polycyclic aromatic hydrocarbons (PAHs). Two greenhouse studies investigated the potential dissipation and plant translocation of PAHs by fescue (*Festuca arundinacea*) and switchgrass (*Panicum virgatum*) in the first experiment and zucchini (*Curcubita pepo* Raven) in the second. The MGP soil was highly hydrophobic and initially inhibited plant growth. Two unplanted controls were established with and without fertilization. In the first experiment, concentrations of PAHs decreased significantly in all treatments after 12 mo. Plant biomass and microbial numbers were statistically equivalent among plant species. PAH concentrations in plant biomass were negligible for fescue and switchgrass. In the second experiment, zucchini enhanced the dissipation of several PAHs after 90 d of treatment when compared to the unvegetated soil. Plant tissue concentrations of PAHs were not elevated in the zucchini roots and shoots, and PAHs were not detectable in the fruit.

Keywords: phytoremediation; plants; microorganisms; biodegradation; polycyclic aromatic hydrocarbons (PAHs); bioremediation; soil; rhizosphere

Naressa Cofield^a; A. Paul Schwab^b; Phillip Williams^c; M. Katherine Banks^a. (^a School of Civil Engineering, Purdue University, Lafayette, Indiana, USA, ^bSchool of Agronomy, Purdue University, Lafayette, Indiana, USA, ^c School of Public Health, University of Georgia, Athens, Georgia, USA). **Phytoremediation of Polycyclic Hydrocarbon Contaminated Soil: Part II. Impact on Ecotoxicity. International Journal of Phytoremediation, Volume 9(5) (2007): 371 - 384**

Several biological assays were used to evaluate the toxic effects of contaminants in soil after phytoremediation. During the treatment process, significant decreases in overall toxicity were observed. Specifically, earthworm survivability and lettuce germination increased over the study period. Microbial respiration improved, but only in planted treatments. Toxicity and total polycyclic aromatic hydrocarbon concentrations showed some correlation, but the relationships generally were not significant. Soil moisture was less of a predictor for biological responses. The presence of plants did not provide a clear advantage for improving toxicity compared to unplanted treatments.

Keywords: phytoremediation; plants; microorganisms; earthworms; polycyclic aromatic hydrocarbons (PAHs); toxicity; soil; contamination

E. Lesage^a, C. Mundia^a, D.P.L. Rousseau^b, A.M.K. Van de Moortel^a, G. Du Laing^a, E. Meers^a, F.M.G. Tack^a, N. De Pauw^c and M.G. Verloo^a. (^aLaboratory of Analytical Chemistry and Applied Ecochemistry, Ghent University, Coupure Links 653, 9000 Ghent, Belgium, ^bDepartment of Environmental Resources, UNESCO-IHE, P.O. Box 3015, 2601 DA Delft, The Netherlands, ^cLaboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, J. Plateaustraat 22, 9000 Ghent, Belgium. *Corresponding author.* Tel.: +32 9 264 59 93; fax: +32 9 264 62 32.). **Sorption of Co, Cu, Ni and Zn from**

industrial effluents by the submerged aquatic macrophyte *Myriophyllum spicatum* L. Ecological Engineering, Volume 30(4) (2007): 320-325

The submerged aquatic plant *Myriophyllum spicatum* L. (Eurasian water milfoil) has been suggested as an efficient plant species for the treatment of metal-contaminated industrial wastewater. The process of metal removal by plants involves a combination of rapid sorption on the surface and slow accumulation and translocation in the biomass. This study focussed on the sorption/desorption characteristics of the surface of *M. spicatum* for Co, Cu, Ni and Zn. Batch sorption tests with mixed metal solutions covering a range of 0, 1, 5, 10, 50 and 100 mg l⁻¹ of each metal, were performed. For Co, Ni and Zn, the sorption process was well described by the Langmuir model, whereas sorption of Cu was better described by the Freundlich model. The biomass showed the highest affinity for Cu and Zn. Langmuir sorption maxima of Co, Ni and Zn were 2.3, 3.0 and 6.8 mg g⁻¹ DM, respectively. At the highest initial concentration of 100 mg l⁻¹, a maximum of 29 mg g⁻¹ DM of Cu was sorbed onto the surface of the biomass. Desorption by 0.1 M HCl did not fully recover the metals sorbed onto the surface and there was evidence of leaching from within the biomass. Recovery of heavy metals and regeneration of the biomass by washing with 0.1 M HCl was therefore not suggested as a viable strategy.

Keywords: Biosorption; Constructed wetlands; Desorption; Eurasian water milfoil; Freundlich; Heavy metals; Langmuir; Regeneration

P. Jankong^a, P. Visoottiviseth^a and S. Khokiattiwong^b. (^aDepartment of Biology, Faculty of Science, Mahidol University, Rama VI Road, Rachataewee, Bangkok 10400, Thailand, ^bPhuket Marine Biological Center, Ministry of Agriculture and Cooperatives, Panwa Cape, Phuket 83000, Thailand. Corresponding author. Tel.: +66 2 201 5272; fax: +66 2 354 7161). **Enhanced phytoremediation of arsenic contaminated land. Chemosphere, Volume 68(10) (2007): 1906-1912**

In an attempt to clean up arsenic (As) contaminated soil, the effects of phosphorus (P) fertilizer and rhizosphere microbes on arsenic accumulation by the silverback fern, *Pityrogramma calomelanos*, were investigated in both greenhouse and field experiments. Field experiments were conducted in Ron Phibun District, an As-contaminated area in Thailand. Soil (136–269 µg As g⁻¹) was collected there and used in the greenhouse experiment. Rhizosphere microbes (bacteria and fungi) were isolated from roots of *P. calomelanos* growing in Ron Phibun District. The results showed that P-fertilizer significantly increased plant biomass and As accumulation of the experimental *P. calomelanos*. Rhizobacteria increased significantly the biomass and As content of the test plants. Thus, P-fertilizer and rhizosphere bacteria enhanced As-phytoextraction. In contrast, rhizofungi reduced significantly As concentration in plants but increased plant biomass. Therefore, rhizosphere fungi exerted their effects on phytostabilization.

Keywords: Arsenic; Phosphorus-fertilizer; Rhizosphere microbes; Phytoremediation; Phytoextraction; Phytostabilization

Asha A. Juwarkar^a, Anupa Nair^a, Kirti V. Dubey^a, S.K. Singh^a and Sukumar Devotta^a. (^aEnvironmental Biotechnology Division, National Environmental Engineering Research Institute (NEERI), Nehru Marg, Nagpur 440 020, India. Corresponding author. Tel.: +91 0712 2249764). **Biosurfactant technology for remediation of cadmium and lead contaminated soils. Chemosphere, Volume 68(10) (2007): 1996-2002**

This research focuses on column experiments conducted to evaluate the potential of environmentally compatible rhamnolipid biosurfactant produced by *Pseudomonas aeruginosa* strain BS2 to remove heavy metals (Cd and Pb) from artificially contaminated soil. Results have shown that di-rhamnolipid removes not only the leachable or available fraction of Cd and Pb but also the bound metals as compared to tap water which removed the mobile fraction only. Washing of contaminated soil with tap water revealed that $\approx 2.7\%$ of Cd and 9.8% of Pb in contaminated soil was in freely available or weakly bound forms whereas washing with rhamnolipid removed 92% of Cd and 88% of Pb after 36 h of leaching. This indicated that di-rhamnolipid selectively favours mobilization of metals in the order of Cd > Pb. Biosurfactant specificity observed towards specific metal will help in preferential elution of specific contaminant using di-rhamnolipid. It was further observed that pH of the leachates collected from heavy metal contaminated soil column treated with di-rhamnolipid solution was low (6.60–6.78) as compared to that of leachates from heavy metal contaminated soil column treated with tap water (pH 6.90–7.25), which showed high dissolution of metal species from the contaminated soil and effective leaching of metals with treatment with biosurfactant. The microbial population of the contaminated soil was increased after removal of metals by biosurfactant indicating the decrease of toxicity of metals to soil microflora. This study shows that biosurfactant technology can be an effective and nondestructive method for bioremediation of cadmium and lead contaminated soil.

Keywords: *Pseudomonas aeruginosa* strain BS2; Di-rhamnolipid biosurfactant; Cadmium; Lead

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Some unavoidable drawbacks of traditional technologies have made phytoremediation a promising alternative for removal of arsenic from contaminated soil and water. In the present study, the potential of an aquatic macrophyte *Spirodela polyrhiza* L. for phytofiltration of arsenic, and the mechanism of the arsenic uptake were investigated. The *S. polyrhiza* L. were grown in three test concentrations of arsenate and dimethylarsinic acid (DMAA) (i.e. 1.0, 2.0 and 4.0 μM) with 0 (control), 100 or 500 μM of phosphate. One control treatment was also set for each test concentrations of arsenic. The PO_4^{3-} concentration in control treatment was 0.02 μM . When *S. polyrhiza* L. was cultivated hydroponically for 6 d in culture solution containing 0.02 μM phosphate and 4.0 μM arsenate or DMAA, the arsenic uptake was $0.353 \pm 0.003 \mu\text{mol g}^{-1}$ and $7.65 \pm 0.27 \text{ nmol g}^{-1}$, respectively. Arsenic uptake into *S. polyrhiza* L. was negatively ($p < 0.05$) correlated with phosphate uptake when arsenate was applied to the culture solutions owing to similar in the sorption mechanism between AsO_4^{3-} and PO_4^{3-} , and positively ($p < 0.05$) correlated with iron uptake due to adsorption of AsO_4^{3-} onto iron oxides. Thus, the *S. polyrhiza* L. accumulates arsenic by physico-chemical adsorption and via the phosphate uptake pathway when arsenate was added to the solutions. These results indicate that *S. polyrhiza* L. would be a good arsenic phytofiltrator. In contrast, DMAA accumulation into *S. polyrhiza* L. was neither affected by the phosphate concentration in the culture nor correlated

($p > 0.05$) with iron accumulation in plant tissues, which indicates that *S. polyrhiza* L. uses different mechanisms for DMAA uptake.

Keywords: Arsenate; DMAA; Duckweed (*Spirodela polyrhiza* L.); Mechanism; Uptake; Physico-chemical adsorption

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Heavy metal analysis of agricultural field soil receiving long-term (>20 years) application of municipal and industrial wastewater showed two- to five-fold accumulation of certain heavy metals as compared to untreated soil. Metal-resistant fungi isolated from wastewater-treated soil belonged to genera *Aspergillus*, *Penicillium*, *Alternaria*, *Geotrichum*, *Fusarium*, *Rhizopus*, *Monilia* and *Trichoderma*. Minimum inhibitory concentrations (MIC) for Cd, Ni, Cr, Cu, and Co were determined. The MIC ranged from 0.2 to 5 mg ml⁻¹ for Cd, followed by Ni (0.1–4 mg ml⁻¹), Cr (0.3–7 mg ml⁻¹), Cu (0.6–9 mg ml⁻¹) and for Co (0.1–5 mg ml⁻¹) depending on the isolate. *Aspergillus* and *Rhizopus* isolates were tested for their metal biosorption potential for Cr and Cd *in vitro*. Biosorption experiments were conducted with initial metal concentrations of 2, 4, 6 and 8 mM with a contact time of 4 h and wet fungal biomass (1–5 g) at 25 °C. Maximum biosorption of Cr and Cd ions was found at 6 mM initial metal concentration. *Aspergillus* sp.1 accumulated 1.20 mg of Cr and 2.72 mg of Cd per gram of biomass. Accumulation of these two metals by very tolerant *Aspergillus* sp.2 isolate was at par with relatively less tolerant *Aspergillus* sp.1 isolate. *Rhizopus* sp. accumulated 4.33 mg of Cr and 2.72 mg of Cd per g of biomass.

The findings indicated promising biosorption of cadmium and chromium by the *Rhizopus* and *Aspergillus* spp. from aqueous solution. There is little, if any, correlation between metal tolerance and biosorption properties of the test fungi.

Keywords: Metal tolerance; Biosorption; Soil fungi

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The aim of this study was to determine the adsorption behaviour of various micronutrient elements e.g., ⁶¹Cu, ^{62,63}Zn, ^{66,67,68}Ga, ^{66,67,69}Ge, ^{71,72}As present in no-carrier-added state, with calcium alginate (CA) using ‘tracer packet’ technique. High Ge and Ga and moderate Cu removal were achieved at pH 7 and pH 5, respectively. Results on the studies to recover all the three radionuclides from the calcium alginate beads using desorbing reagents, HCl, thiourea, ammonium oxalate and sodium nitrite showed that 0.1 M HCl and 0.1 M ammonium oxalate removed Cu and Ge moderately. The amount of Ga desorbed by all the washing liquids was almost negligible, except sodium nitrite.

Keywords: Tracer packet; Micronutrient elements; No-carrier-added; Biopolymer; Calcium alginate beads

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Sorption capacity of six different algae (green, red and brown) was evaluated in the recovery of cadmium, nickel, zinc, copper and lead from aqueous solutions. The optimum sorption conditions were studied for each monometallic system. The optimum pH was 6 for the recovery of Cd, Ni and Zn, and less than 5 for Cu and Pb. The best results were obtained with the lowest biomass concentration used (0.5 g/L). Experimental data fitted a Langmuir model very well according to the following sequence of the sorption values: Pb > Cd ≥ Cu > Zn > Ni. The brown algae achieved the lowest metal concentration levels in solution; the best results were obtained with *Fucus spiralis*. Finally, a software computer program was used to simulate the process by comparison of theoretical with experimental results and show minimum differences between both types of data.

Keywords: Algae; Biosorption; Heavy metals; Simulation

Aynur Demir^a and Münevver Arisoy^b. (^aInstitute of Biotechnology of Ankara University, Ankara, Turkey, ^bInstitute of Biotechnology-Faculty of Health Sciences of Ankara University, Ankara, Turkey. Corresponding author at: Ankara University, Health Science Faculty, Fatih St. No: 197, Keçiören, Ankara, Turkey. Tel.: +90 312 357 14 24; fax: +90 312 357 5323). **Biological and chemical removal of Cr(VI) from waste water: Cost and benefit analysis. Journal of Hazardous Materials, Volume 147(1-2) (2007): 275-280**

The objective of the present study is cost and benefit analysis of biological and chemical removal of hexavalent chromium [Cr(VI)] ions. Cost and benefit analysis were done with refer to two separate studies on removal of Cr(VI), one of heavy metals with a crucial role concerning increase in environmental pollution and disturbance of ecological balance, through biological adsorption and chemical ion-exchange.

Methods of biological and chemical removal were compared with regard to their cost and percentage in chrome removal. According to the result of the comparison, cost per unit in chemical removal was calculated €0.24 and the ratio of chrome removal was 99.68%, whereas those of biological removal were €0.14 and 59.3%. Therefore, it was seen that cost per unit in chemical removal and chrome removal ratio were higher than those of biological removal method. In the current study where chrome removal is seen as immeasurable benefit in terms of human health and the environment, percentages of chrome removal were taken as measurable benefit and cost per unit of the chemicals as measurable cost.

Keywords: Cost and benefit analysis; Heavy metal; Chrome; Adsorption; Ion-exchange

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The efficiency of different bioremediation products (nutrients, microorganisms and biodiesel) was tested using tiles located in both the supra-littoral and intertidal zones of a beach that was affected by the heavy oil spill of the Prestige. Neither nutrients nor microorganisms meant an improvement with respect to the natural processes. The addition of biodiesel improved the appearance of the treated tiles and apparently accelerated the degradation of the aliphatic and aromatic fractions of the residual fuel oil. Nevertheless, PAHs degradation was similar and very high in all the treatments (80–85% after 60 days). On the other hand, the evolution with time of the amount of vanadium was similar to that of 17 α (H),21 β (H)-hopane, so it was concluded that vanadium could also be used to estimate the extent of oil degradation in the field. These results also suggested that the residual fuel oil mineralization was very low throughout 1 year in all the treatments. Moreover, the increase of the oxygen content of the residual oil from around 1% till 4–8% indicated that the partial oxidation of hydrocarbons took place, and that the hydrocarbon oxidation products accumulated in the polar fractions. In general, the results pointed out that bioremediation techniques were not suitable for the recovery of shores affected by heavy oil spills.

Keywords: Prestige oil spill; Bioremediation; Biodiesel; Vanadium

L. Cancho^a, M.L. Blázquez^a, A. Ballester^a, F. González^a and J.A. Muñoz^a. (^aDepartment of Materials Science and Metallurgical Engineering, Universidad Complutense, Madrid, Spain. Corresponding author. Tel.: +34 91 394 4339; fax: +34 91 394 4357). **Biobleaching of a chalcopyrite concentrate with moderate thermophilic microorganisms in a continuous reactor system. *Hydrometallurgy*, Volume 87(3-4) (2007): 100-111**

The metal extraction efficiency of bioleaching processes can be greatly improved by using stirred-tank reactors. However, owing to the high cost of acquiring and maintaining these, their use is restricted to the treatment of high-grade ores and concentrates. Unlike gold, the copper industry is not far from achieving commercial implementation of stirred processes on an industrial scale. Recent research has focused on the development of continuous bioleaching processes for the treatment of copper flotation concentrates.

The aim of the present work was to optimize a process for continuous bioleaching of chalcopyrite concentrates using moderate thermophilic microorganisms and silver ions. The best results were obtained using a series of three reactors under the following experimental conditions: 45 °C, 14 days residence time, 2 g Ag/kg of concentrate (silver deposition stage at 35 °C), stirring rate adjusted to 350 rpm, pH between 1.2 and 1.4 and redox potential between 400 and 500 mV vs. Ag/AgCl. The optimized continuous bioleaching system was able to dissolve copper steadily at a concentration higher than 11 g/L.

Keywords: Copper flotation concentrate; Continuous bioleaching; Moderate thermophilic microorganisms; Silver catalysis

Bestamin Ozkaya^a, Erkan Sahinkaya^a, Pauliina Nurmi^a, Anna H. Kaksonen^a and Jaakko A. Puhakka^a. (^aInstitute of Environmental Engineering and Biotechnology, Tampere University of Technology, P.O. Box 541, FIN-33101 Tampere, Finland. Corresponding author. Tel.: +358 3 3115 2758; fax: +358 3 3115 2869). **Iron oxidation and precipitation in a simulated heap leaching solution in a *Leptospirillum ferriphilum* dominated biofilm reactor. Hydrometallurgy, Volume 88(1-4) (2007): 67-74**

Iron is a key element influencing bacterial growth, oxidation efficiency and precipitate formation for most industrial applications using bioleaching and biooxidation processes. In this study, iron oxidation by an enrichment culture dominated by *Leptospirillum ferriphilum* was studied in a simulated heap leaching solution containing (g/L); Fe²⁺ (20); Mn²⁺ (3); Mg²⁺ (4); Al³⁺ (0.1); Na⁺ (3.6); Ca²⁺ (0.6). Initially, studies were conducted in batch bottles at 25 °C in order to determine possible toxicity effect and settling properties of precipitates produced at different pHs. Settling characteristics including interface height, zone settling velocity and sludge volume index were determined. The precipitates had good settling ability. Thereafter, a continuous-flow fluidized-bed reactor (FBR) was operated at 37 °C. The percent iron oxidation in the FBR decreased gradually from 98.5% to around 60% within 20 d due to precipitate formation. After installing a gravity settler to the recycle line of the FBR, the iron oxidation rate increased from 2 to 4 g Fe²⁺/L·h within 15 d. The maximum Fe²⁺ oxidation rate was 10 g Fe²⁺/L·h at a HRT of 2 h and optimum oxidation performance was achieved at a loading rate of 10.7 g Fe²⁺/L·h. The oxygen mass transfer limited the Fe²⁺ oxidation corresponding to an oxygen transfer rate of 35 kg O₂/m³·d. This study reveals that a FBR combined with a gravity settler in the recycle line has potential for Fe³⁺ regeneration in heap leaching of sulfidic minerals.

Keywords: Heap leaching; Fluidized-bed reactor; Iron oxidation; Iron oxide precipitation; *Leptospirillum ferriphilum*

Sadia Ilyas^a, Munir A. Anwar^b, Shahida B. Niazi^a and M. Afzal Ghauri^b. (^aDepartment of Chemistry, Bahauddin Zakriya University Multan, Pakistan, ^bBioprocess Technology Division, National Institute for Biotechnology and Genetic Engineering (NIBGE), P. O. Box 577, Jhang Road, Faisalabad, Pakistan. Corresponding author. Present Address: Groningen Biomolecular Sciences and Biotechnology Institute, University of Groningen, Kerklaan 30, 9751 NN, Haren, The Netherlands. Tel.: +31 50 363 7831; fax: +31 50 363 2154). **Bioleaching of metals from electronic scrap by moderately thermophilic acidophilic bacteria. Hydrometallurgy, Volume 88(1-4) (2007):180-188**

The present work was aimed at studying the bioleachability of metals from electronic scrap by the selected moderately thermophilic strains of acidophilic chemolithotrophic and acidophilic heterotrophic bacteria. These included *Sulfobacillus thermosulfidooxidans* and an unidentified acidophilic heterotroph (code AITSB) isolated from local environments. Among the strategies adapted to obtain enhanced metal leaching rates from electronic scrap, a mixed consortium of the metal adapted cultures of the above-mentioned bacteria was found to exhibit the maximum metal leaching efficiency. In all the flasks where high metal leaching rates were observed, concomitantly biomass production rates were also high indicating high growth rates. It showed that the metal bioleaching capability of the bacteria was associated with their growth. At scrap concentration of 10 g/L, a mixed consortium of the metal adapted cultures was able to leach

more than 81% of Ni, 89% of Cu, 79% of Al and 83% of Zn. Although Pb and Sn were also leached out, they were detected in the precipitates formed during bioleaching.

Keywords: Electronic scrap; Bioleaching; Metals; Moderate thermophiles; *Sulfobacillus thermosulfidooxidans*; Acidophilic heterotrophs

D. Mishra^{a, b}, D.J. Kim^a, D.E. Ralph^c J.G. Ahn^a and Y.H. Rhee^b. (^aMineral and Material Processing Division, Korea Institute of Geosciences and Mineral Resources, Daejeon, 305-350, South Korea, ^bDepartment of Microbiology, Chungnam National University, Daejeon, 305-764, South Korea, ^cAJ Parker CRC for Hydrometallurgy, Murdoch University, South St., Murdoch, Perth 6153, Australia. Corresponding author. Tel.: +82 42 8683592; fax: +82 42 8619727). **Bioleaching of vanadium rich spent refinery catalysts using sulfur oxidizing lithotrophs. *Hydrometallurgy*, Volume 88(1-4) (2007): 202-209**

Bioleaching process was attempted by using chemo-lithotrophic sulfur oxidizing bacteria to recover valuable metals from vanadium-rich spent refinery catalysts. Prior to the bioleaching process, the spent refinery catalyst was pre-treated with acetone as the solvent. The bioleaching process was carried out in one-step and two-step methods and the leaching efficiencies in both the cases were compared. Bacteria were grown in the presence of up to 50 g/L of spent catalyst using elemental sulfur as the major substrate in the leaching medium. Varying the spent catalyst concentration in the bacterial growth medium in the one-step process conducted at pH 2–3 resulted in different amounts of solubilized metals. The maximum extraction yield of metals (88.3% Ni, 58.0% Mo and 32.3% V) was obtained with a concentration of 15 g/L spent catalyst. In the two-step process, the sulfur oxidizing bacteria were first cultivated in the presence of elemental sulfur in the growth medium, and the bacterially produced acid medium at pH 0.9–1.0 was subsequently used as the leaching agent. In this study, at 50 g/L spent catalyst concentration, 88.3% Ni, 46.3% Mo and V 94.8% were recovered after 7 days. Chemical leaching with commercial sulfuric acid was compared with the two-step process and the suitability of the two-step process was demonstrated. In all the processes studied, however, a significant amount of molybdenum was found to be lost to the solid phase as MoO₃.

Keywords: Spent catalysts; Molybdenum; Vanadium; Bioleaching; Sulfur oxidizing bacteria; Metal recovery

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Bioleaching of low-grade complex sulfide ores from La Silvita and La Resbalosa (Patagonia Argentina) were carried out in a reverse flow airlift reactor by a native strain of *Leptospirillum ferrooxidans* (Lf-LS04). The reactor was filled with iron free 9K medium pH 1.8, with mineral particle size of – 74 µm, pulp density of 1% and a superficial air velocity of 0.01m s⁻¹.

Zinc recoveries from the two sulfide ores – mainly in the case of La Silvita ore – were higher than those obtained previously with a collection strain of *A. ferrooxidans*. By applying the shrinking core-product layer diffusion model to sphalerite leaching, diffusion was found to be

rate limiting due to the formation of an insoluble product layer (elemental sulfur, anglesite and ferric iron precipitates) as well as to the presence of an unreacted layer of gangue minerals (quartz, feldspar). Even in this case, the indigenous strain of *L. ferrooxidans* was shown to be highly efficient for processing both complex sulfides in the absence of sulfur-oxidizing bacteria.

Keywords: Bioleaching; Zinc; *Leptospirillum*; Sulfide ores; Airlift reactor

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Non-living (dried) biomass of five common filamentous algae belonging to Chlorophyta and Cyanophyta (Cyanobacteria) were screened for their metal ion sorption and removal efficiency in a batch system. A considerably higher magnitude of sorption of Pb²⁺ and Cu²⁺ by all the tested algae suggests the prevalence of Pb²⁺- and Cu²⁺-binding ligands in them. The Langmuir isotherm could more appropriately describe metal sorption by the test algae than the Freundlich isotherm. A 1 g l⁻¹ biomass concentration of *Pithophora oedogonia* and *Spirogyra neglecta*, respectively removed 97 and 89% Pb²⁺ in 30 min from a solution containing 5 mg l⁻¹ initial concentration of Pb²⁺. Metal ion removal by the test algae decreased with increase in metal concentration in the solution. *S. neglecta* could remove >70% Pb²⁺ even from a solution containing 75 mg Pb²⁺ l⁻¹. *S. neglecta* and *P. oedogonia* could remove more than 75% of Pb²⁺ and Cu²⁺ from a multi-metal solution, and therefore have tremendous potential for removing Pb²⁺ and Cu²⁺ from wastewaters containing several metal ions simultaneously. Other test algae, namely, *Hydrodictyon reticulatum*, *Cladophora calliceima* and *Aulosira fertilissima* were relatively less efficient in removing metal ions from solution.

Keywords: Biosorption - Heavy metal - Filamentous algae - Freundlich isotherm - Langmuir isotherm - Metal removal

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Arsenic (As) is a very toxic metalloid to a great number of organisms. It is one of the most important global environmental pollutants. To resist the arsenate invasion, some microorganisms have developed or acquired genes that permit the cell to neutralize the toxic effects of arsenic through the exclusion of arsenic from the cells. In this work, two arsenic resistance genes, *arsA* and *arsC*, were identified in three strains of *Rhizobium* isolated from nodules of legumes that grew in contaminated soils with effluents from the chemical and fertilizer industry containing heavy-metals, in the industrial area of Estarreja, Portugal. The *arsC* gene was identified in strains of *Sinorhizobium loti* [DQ398936], *Rhizobium leguminosarum* [DQ398938] and *Mesorhizobium loti* [DQ398939]. This is the first time that arsenic resistance genes, namely *arsC*, have been identified in *Rhizobium leguminosarum* strains. The search for the *arsA* gene

revealed that not all the strains with the arsenate reductase gene had a positive result for *ArsA*, the ATPase for the arsenite-translocating system. Only in *Mesorhizobium loti* was the *arsA* gene amplified [DQ398940]. The presence of an arsenate reductase in these strains and the identification of the *arsA* gene in *Mesorhizobium loti*, confirm the presence of an *ars* operon and consequently arsenate resistance.

Keywords Arsenic - *ars* operon - *arsC* - *arsA* - *Mesorhizobium loti* - *Rhizobium leguminosarum*

Tran Thi Hien Hoa^a, Warounsak Liamleam^a and Ajit P. Annachhatre^a (^aEnvironmental Engineering and Management, Asian Institute of Technology, P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand. Corresponding author. Tel./fax: +66 2 524 5644). Lead removal through biological sulfate reduction process. *Bioresource Technology*, Volume 98(13) (2007): 2538-2548

The feasibility of lead removal through biological sulfate reduction process with ethanol as electron donor was investigated. Sulfide-rich effluent from biological process was used to remove lead as lead sulfide precipitate. The experiments were divided into two stages; Stage I startup and operation of sulfidogenic process in a UASB reactor and Stage II lead sulfide precipitation. In Stage I, the COD:S ratio was gradually reduced from 15:1 to 2:1. At the COD:S ratio of 2:1, sulfidogenic condition was achieved as identified by 80–85% of electron flow by sulfate reducing bacteria (SRB). COD and sulfate removal efficiency were approximately 78% and 50%, respectively. In Stage II, the effluent from UASB reactor containing sulfide in the range of 30–50 mg/L and lead-containing solution of 45–50 mg/L were fed continuously into the precipitation chamber in which the optimum pH for lead sulfide precipitation of 7.5–8.5 was maintained. It was found that lead removal of 85–95% was attained.

Keywords: Sulfate reduction; UASB process; COD:S ratio; Electron flow; Lead sulfide precipitation

Biotransformation

Magdalena V. Monferran^a, Daniel A. Wunderlin^a, Jorge Nimptsch^b and Stephan Pflugmacher^b. (^aUniversidad Nacional de Córdoba, CONICET, Facultad de Ciencias Químicas, Dto. Bioquímica Clínica, CIBICI, Haya de la Torre esq. Medina Allende, Ciudad Universitaria, 5000 Córdoba, Argentina, ^bLeibniz Institute of Freshwater Ecology and Inland Fisheries, Müggelseedamm 301, 12587 Berlin, Germany. Corresponding author. Tel.: +49 30 64181 639; fax: +49 30 64181 682). Biotransformation and antioxidant response in *Ceratophyllum demersum* experimentally exposed to 1,2- and 1,4-dichlorobenzene. *Chemosphere*, Volume 68(11) (2007): 2073-2079

We report the effects of 1,2- and 1,4-dichlorobenzene (1,2-DCB and 1,4-DCB) on the aquatic macrophyte *Ceratophyllum demersum*. We evaluated the response of the antioxidant system through the assay of glutathione reductase (GR), guaiacol peroxidase (POD) and glutathione peroxidase (GPx). Additionally, the effect of DCBs on the detoxication system by measuring the activity of glutathione-S-transferase (GST) was evaluated.

C. demersum showed elevated GST activities when exposed to 10 and 20 mg l⁻¹ 1,2-DCB, and at 10 mg l⁻¹ for 1,4-DCB. These results show that glutathione conjugation take place at relatively high concentrations of both isomers. Significantly increased activities of POD were also detected in *C. demersum* exposed to concentrations above 5 mg l⁻¹ of the corresponding isomer.

The GR activity was enhanced in plants exposed to 1,2-DCB (5 mg l⁻¹) and 1,4-DCB (10 mg l⁻¹). GPx was also significantly increased in exposures to the corresponding isomer, each at a concentration of 10 mg l⁻¹. However, plants exposed to low doses of 1,4-DCB (1 mg l⁻¹) showed significantly decreased activities of both enzymes GR and GPx.

Consequently, it is clear that the exposure of the aquatic macrophyte *C. demersum* to DCBs is able to cause an activation of the antioxidant system, showing an isomer specific pattern, which suggests that the defence system of this plant is playing an important role in scavenging ROS, helping to protect the organism against adverse oxidative effects generated by the prooxidant action of the tested xenobiotics. Furthermore, increased GST activities give indirect evidence on the conjugation of either DCBs or the corresponding metabolites during phase II of detoxication, which supports the elimination process of toxic metabolites from cells of *C. demersum*.

Keywords: DCBs; ROS; Macrophytes; Antioxidant; Detoxification; GSH

Zainul Akmar Zakaria^a, Zainoha Zakaria^a, Salmijah Surif^b and Wan Azlina Ahmad^a. (^aDepartment of Chemistry, Faculty of Science, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia, ^bDepartment of Environmental Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia. Corresponding author. Tel.: +60 7 5534546; fax: +60 7 5534546). **Hexavalent chromium reduction by *Acinetobacter haemolyticus* isolated from heavy-metal contaminated wastewater. Journal of Hazardous Materials, Volume 146(1-2) (2007): 30-38**

Possible application of a locally isolated environmental isolate, *Acinetobacter haemolyticus* to remediate Cr(VI) contamination in water system was demonstrated. Cr(VI) reduction by *A. haemolyticus* seems to favour the lower concentrations (10–30 mg/L). However, incomplete Cr(VI) reduction occurred at 70–100 mg/L Cr(VI). Initial specific reduction rate increased with Cr(VI) concentrations. Cr(VI) reduction was not affected by 1 or 10 mM sodium azide (metabolic inhibitor), 10 mM of PO₄³⁻, SO₄²⁻, SO₃²⁻, NO₃⁻ or 30 mg/L of Pb(II), Zn(II), Cd(II) ions. However, heat treatment caused significant dropped in Cr(VI) reduction to less than 20% only. *A. haemolyticus* cells loses its shape and size after exposure to 10 and 50 mg Cr(VI)/L as revealed from TEM examination. The presence of electron-dense particles in the cytoplasmic region of the bacteria suggested deposition of chromium in the cells.

Keywords: Reduction; *Acinetobacter*; Cr(VI); TEM; Heavy-metal

Ping Xu^{1, 2, 3}, Dongliang Hua^{2, 3}, and Cuiqing Ma³. (¹Institute of Microbiology, Chinese Academy of Sciences, Datun Road, Chaoyang District, Beijing 100101, PR China, ²Key Laboratory of Microbial Metabolism, Ministry of Education, College of Life Science and Biotechnology, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai 200240, PR China, ³State Key Laboratory of Microbial Technology, Shandong University, 27 Shanda Nanlu, Jinan 250100, PR China). **Microbial transformation of propenylbenzenes for natural flavour production. Trends in Biotechnology, Volume 25(12) (2007): 571-576**

Propenylbenzenes are common aromatic compounds that are often used as starting compounds for the production of various flavours. Recently, microbial transformation has emerged as an important approach for producing natural flavours in high quantities. Because the biotransformation processes are environmentally friendly and the products are considered 'natural', flavour production using this method is attracting more and more attention. This paper reviews recent advances in the application of microbial metabolism to propenylbenzenes and in subsequent flavour production. Vanillin, a valuable aromatic compound, is used as a model to show recent progress in high-value natural flavour production. Future research should focus on metabolic-mechanism characterisation and on optimisation of biotransformation to improve the yields of target products for scale-up and industrial use.

Biomarker

Marcelo Enrique Conti, Marta Iacobucci, Gaetano Cecchetti. (Dipartimento di Controllo e Gestione delle Merci e del loro Impatto sull 'Ambiente, Universita di Roma 'La Sapienza', Via del Castro Laurenziano 9, 00161, Rome, Italy. ' Facolta di Scienze Ambientali, Centro per le Valutazioni Ambientali delle Attivita Industriali, Universita degli Studi di Urbino, Campus Scientifico Sogesta, 61029 Urbino (Pu), Italy. ' Facolta di Scienze Ambientali, Centro per le Valutazioni Ambientali delle Attivita Industriali, Universita degli Studi di Urbino, Campus Scientifico Sogesta, 61029 Urbino (Pu), Italy). A biomonitoring study: trace metals in seagrass, algae and molluscs in a marine reference ecosystem (Southern Tyrrhenian Sea. *International Journal of Environment and Pollution, Vol. 29(1/2/3) (2007): 308 – 332*

Marine organisms were tested as possible biomonitors of heavy metal contamination in Ustica (island of the Southern Tyrrhenian Sea). The concentrations of Cd, Cr, Cu, Pb and Zn were measured in the phanerogam *Posidonia oceanica* L. Delile, the two brown algae *Padina pavonica* (L.) Thivy and *Cystoseira* sp., and the two gastropod molluscs *Monodonta turbinata* Born and *Patella caerulea* L. collected at five coastal stations on the island of Ustica. The biomonitors examined showed a high ability to accumulate metals, with concentration factors higher than 10^3 , with respect to the concentration (soluble fraction) in marine waters. The data from this study were also compared with those previously obtained from uncontaminated sites in the Sicilian sea (Favignana island, Italy) and those obtained from the area of the Gulf of Gaeta (Tyrrhenian Sea, central Italy). Results clearly show the diversity between these three marine ecosystems.

Keywords:biomonitoring; trace metals; marine ecosystems; Tyrrhenian Sea; *Posidonia oceanica*; *Padina pavonica*; *Cystoseira* sp.; *Monodonta turbinata*; *Patella caerulea*; seagrass; algae; molluscs; Italy; pollution prevention; environmental pollution; water pollution.

Rim Ladhar-Chaabouni, Raja Gargouri, Amel Hamza Chaffai. (Marine Ecotoxicology UR 09-03, IPEIs BP 805, 3018 Sfax, Tunisia. ' Laboratoire Genetique Moleculaire des Eucaryotes, Centre de Biotechnologie de Sfax, BPK 3038 Sfax, Tunisia. ' Marine Ecotoxicology UR 09-03, IPEIs BP 805, 3018 Sfax, Tunisia). Effect of cadmium on some biomarkers in the clam *Ruditapes decussatus*: metallothionein quantification using two

techniques. *International Journal of Environment and Pollution, Vol. 30(3/4) (2007): 593 – 605*

After the contamination of *Ruditapes decussatus* with 100 µg/l and 200 µg/l of cadmium chloride during 21 days, metallothioneins (MTs), malondialdehyde (MDA) and cadmium concentrations were determined in the gills and the digestive gland. The results showed an increase of Cd, MTs and MDA concentrations in the gills and the digestive gland. No significant variations of the concentrations with sex were observed. Two techniques (polarography and colorimetry) for metallothionein quantification were compared. The results showed that the polarographic method is more sensitive than the colorimetric one.

Keywords: biomarkers; cadmium contamination; malondialdehyde; metallothioneins; *Ruditapes decussatus*; clams; heavy metals; biomonitoring; environmental pollution.

K. Thamayanthi, R. Kannan and V.R.K. Reddy. (Cytogenetics Laboratory, Department of Botany, Bharathiar University Coimbatore – 641 045, T.N., India. *Biochemical Characterization of Rust Resistance I Wheat (Triticum aestivum L.). Ad. Plant Sci. 20(II) (20074): 589 – 596.*

Near-isogenic wheat lines carrying various rust resistance genes were used to confirm the presence of rust resistance genes in four Indian wheats. Changes in enzymatic activities of various biochemical parameters such as peroxidase activity, polyphenol oxidase activity, catalase activity, Lipoxygenase activity, Lipid contents, total soluble proteins, free phenols & tannins, ribonuclease, chlorophyll, free amino acids, free proline and respiration rate were used to confirm the gene transfers. Changes in these biochemical parameters were discussed in the light of rust resistance in hexaploid wheat.

Keywords: Wheat, near-isogenic, rust resistance, biochemical markers.

Biofertilizer

A. Adoki^{1*} and T. Orugbani². (¹Health Safety and Environment, Shell Petroleum Development Company Limited, P. O. Box 263, Old Aba Road, Port Harcourt, Nigeria, ²Department of Biological Sciences, Rivers State University of Science & Technology, P.M.B 5080, Port Harcourt, Nigeria. *Corresponding author. E-mail: akuro.adoki@shell.com). *Removal of crude petroleum hydrocarbons by heterotrophic bacteria in soils amended with nitrogenous fertilizer plant effluents. African Journal of Biotechnology, Vol. 6 (13)(2007):1529-1535*

Nitrogenous fertilizer (NPK) plant effluents from NAFCON were used in amending plots of land experimentally polluted with crude oil. Counts of heterotrophic bacteria (THBC) and fungi (TF), and of petroleum utilizing bacteria (PUB) and fungi (PUF) were monitored during an 8 weeks period. Counts obtained showed that NPK served as a good supplement for the growth of the petroleum degrading/utilizing bacteria in oil-polluted soils. Crude oil disappearance in plots TSP ranged between 8.70 and 34.80% and 20.90 and 60.50% for TST; cumulative loss was 73.0%. The disappearance was influenced by the N/P ratio in the supplementing fertilizer effluent. A

total of ten genera of petroleum degraders were isolated, namely, *Micrococcus*, *Pseudomonas*, *Acinetobacter*, *Proteus*, *Bacillus*, *Actinomyces*, *Corynebacterium*, *Enterobacter*, *Brevibacteria* and *Citrobacter*. Crops grown on the experimental plots at the end of the study period for soil recovery studies indicated good soil recovery.

Key words: Removal, petroleum, heterotrophic, bacteria, amendment, fertilizer, effluents.

Saswati Nayak¹, Radha Prasanna¹, Boddupalli M. Prasanna² and Dina B. Sahoo³. (¹Centre for Conservation & Utilization of Blue-Green Algae (CCUBGA), Indian Agricultural Research Institute (IARI), New Delhi, 110012, India, ²Division of Genetics, IARI, New Delhi, 110012, India, ³Department of Botany, Delhi University (North Campus), Delhi, 110007, India. Radha Prasanna, Email: radhapr@gmail.com). **Analysing diversity among Indian isolates of *Anabaena* (Nostocales, Cyanophyta) using morphological, physiological and biochemical characters. World Journal of Microbiology and Biotechnology, Volume 23(11) (2007): 1575-1584**

A set of 24 strains belonging to the genus *Anabaena* (Phylum Cyanobacteria), isolated from diverse geographic locations in India, were evaluated along with three International type strains of *Anabaena* (ATCC 29414, ATCC 29208 and ATCC 27899) for their morphological, physiological and biochemical diversity. The morphological dataset, consisting of 58 variants for 15 characters, and SDS-PAGE protein profiles comprising 17 polymorphic bands were utilized to differentiate the selected *Anabaena* strains and explore the patterns of diversity through cluster analysis. Physiological and biochemical characterization with respect to nitrogen fixation and accumulation of chlorophyll and phycobiliproteins led to the identification of some highly promising *Anabaena* strains for use as biofertilizers and source of pigments. The study highlighted the tremendous inter and intraspecific diversity within the *Anabaena* isolates and indicated the potential as well as constraints of the morphological and protein profiling datasets for unambiguous differentiation and analyses of diversity among the *Anabaena* strains.

Keywords: *Anabaena* - Diversity - Morphology - Nitrogen fixation - Pigments - Protein profiles

Swalin Gauhar and Manoj Raghav*. (Department of Vegetable Science, G.B.Pant University of Agriculture Y Technology, Pantnagar 263 145, India. Correspondence: raghav1963@yahoo.co.in). **Effect of N and P Levels with and without Biofertilizers on N and P Content, Uptake and Yield of Potato cv Kufri Jawahar. Environment & Ecology 25S (3A) (2007): 788 – 791.**

The field experiment was conducted to assess the efficacy of nitrogen and phosphorus nutrients, with or without biofertilizers on nutrient content uptake and yield of potato. Application of 160 kg N + 100 kg P₂O₅ 120 kg K₂O/ha and soaking of seed tubers in solution containing 1% urea and sodium bicarbonate Azotobacter and phosphobacteria was beneficial in increasing N and P content and uptake by haulm and tubers of potato and tuber yield, which was closely followed by application of 120 kg N+ 80 kg P₂O₅ 120 kg K₂O/ha+soaking of seed tubers in 1% solution of urea and sodium bicarbonate + Azotobacter and phosphobacteria.

Keywords: Potato, Biofertilizers, Nitrogen content, Uptake, Phosphorus content.

D.Jawahar and S. Suresh. (Unit of Soil Science and Agricultural Chemistry, Agricultural College and Research Institute. Killikalamb, Vallanad – 628 252, Tamil Nadu, India). Effect of Biofertilizers and Enriched FYM on the Yield of Cotton Under Dry Farming in Vertisol. Ad. Plant Sci. 20(II) (2007): 473 - 475.

Field experiments were conducted to study the effect of biofertilizers and enriched FYM (EFYM) on the yield of cotton in a vertisol under dry farming. The result revealed that the seed cotton yield was maximum in the treatment with the application of 20 kg P₂O₅/ha as enriched farm yard manure + 75 per cent N along with Azospirillum and Phosphobacteria in both the two years. This was followed by the treatment of application of 20 kg P₂O₅/ha as EFYM + 100% N application along with Azospirillum and Phosphobacteria. The application of 20 kg P₂O₅/ha as EFYM + 75% N along with Azospirillum and Phosphobacteria recorded significantly higher plant height (72.4 cm), number of symbiodial branches/plant (6.3) and number of bolls/plant (7.9). The uptake of N,P and K were also the highest with the above treatment. This treatment recorded significantly higher yield than the application of 100% recommended N and inorganic fertilizer. The residual soil available N and P did not follow a definite trend. But the residual soil organic carbon and available K were not significantly influenced by the different treatments tried. A nitrogen dose of 30 kg/ha (I.e., 75 per cent of therecommended dosage of 40 kg/ha) along with 20 kg P₂O₅/ha as enriched farm yard manure can be recommended for cotton to produce maximum yields and sustaining the productivity. A saving of 10 kg N ha⁻¹ was observed over the normal recommended dose of inorganic N fertilizer when biofertilizers and enriched FYM were applied.

Keywords: Biofertilizers, Enriched Farm Yard Manure, Rainfed cotton, Vertisol.

P. Kumudha and M. Gomathinayagam*. (Department of Botany, Vellalar College for Women, Erode, Tamil Nadu. *Dept of Botany, Annamalai University, Annamalai Nagar, Chidambaram). Studies on the Effect of Biofertilizers on Germination n Albizia lebbek (L) Benth. Seeds. Ad. Plant Sci. 20(II) (2007): 417 – 421.

A study was conducted with the seeds of Albizia lebbek to elucidate the effects of Rhizobium (18g/Pot). Phosphobacteria (18 g/pot) and VAM fungi (45 g/pot) individually and in conjunction on the germination, seedling growth, physiological and biochemical parameters such as chlorophyll 'a', chlorophyll 'b' total chlorophyll, total soluble carbohydrates, reducing sugars, total free amino acids, total proteins, total free phenolics N, P. K. Ca and Mg under pot culture conditions. The results indicated that Albizia lebbek seeds inoculated with all the reemployed biofertilizers showed better performance compared to control. Combined inoculation of Rhizobium + VAM improved the germination, growth and most of the biochemical parameters compared to control. VAM inoculation was found to be the best for the accumulation of chlorophyll pigments.

Keywords: Albizia lebbek, biofertilizers, Rhizobium, VAM, phosphobacteria.

Biocomposting

Federico A. Gutiérrez-Miceli^{a, 1}, Jorge Santiago-Borraz^{a, 1}, Joaquín Adolfo Montes Molina^{a, 1}, Camerino Carlos Nafate^{a, 1}, Miguel Abud-Archila^{a, 1}, María Angela Oliva Llaven^b, Reiner Rincón-Rosales^c and Luc Dendooven^c. (^aInstituto Tecnológico de Tuxtla Gutiérrez. Carr. Panamericana km. 1080, Tuxtla Gutiérrez, Chiapas, Mexico, ^bFacultad de Medicina veterinaria y Zootecnia, Universidad Autónoma de Chiapas, Mexico, ^cCinvestav, Dept. Biotechnology and Bioengineering, Av. Instituto Politécnico Nacional 2508, C.P. 07000, México D.F., Mexico. Corresponding author. Tel.: +52 55 5061 3311; fax: +52 55 5061 3313. ¹ Tel.: +52 961 61 50380; fax: +52 961 61 51687). **Vermicompost as a soil supplement to improve growth, yield and fruit quality of tomato (*Lycopersicum esculentum*).** *Bioresource Technology*, Volume 98(15) (2007): 2781-2786

The effects of earthworm-processed sheep-manure (vermicompost) on the growth, productivity and chemical characteristics of tomatoes (*Lycopersicum esculentum*) (c.v. Rio Grande) were investigated in a greenhouse experiment. Five treatments were applied combining vermicompost and soil in proportions of 0:1, 1:1, 1:2, 1:3, 1:4 and 1:5 (v/v). Growth and yield parameters were measured 85 days and 100 days after transplanting. Addition of vermicompost increased plant heights significantly, but had no significant effect on the numbers of leaves or yields 85 days after transplanting. Yields of tomatoes were significantly greater when the relationship vermicompost:soil was 1:1, 1:2 or 1:3, 100 days after transplanting. Addition of sheep-manure vermicompost decreased soil pH, titratable acidity and increased soluble and insoluble solids, in tomato fruits compared to those harvested from plants cultivated in unamended soil. Sheep-manure vermicompost as a soil supplement increased tomato yields and soluble, insoluble solids and carbohydrate concentrations.

Keywords: Chemical composition; Fruit characteristics; Sheep manure; Tomato; Vermicompost; Soil supplement

R.S.Singh. (Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 21 005, India). Effect of Organic and Inorganic Sources of Nutrition on Productivity of Long Duration Pigeonpea (*Cajanus cajan* (L) Millsp). *Environment & Ecology* 25S (3A) (2007): 768 – 770.

A field experiment was conducted during rainy season of 2002-03 and 2003-04 to study the effect of organic (5t FYM, 10t FYM, it vermicompost and 2t vermicompost /ha) and inorganic sources (50% RDF, 100% RDF, 50% RDF + it vermicompost/ha) of nutrition of growth, yield attributes, yield and nutrient uptake of pigeonpea. The results showed that the application of 50% RDF + 5t FYM/ha remained at par with 10t FYM/ha, 100% RDF and recorded significantly taller plants (211.4cm), maximum number of branches (38.7), dry matter/plant (167.5g), grain yield (26.5 q/ha), stalk yield (98.4 q/ha) and uptake of N (150.8 kg/ha), P (31.9 kg/ha), K (98.7 kg/ha). Net return (Rs. 32, 190) was also higher with 50% RDF + 5t FYM/ha.

Keywords: Organic Inorganic, FYM, Vermicompost, Pigeonpea.

R. Bakthavathsalam. (Department of Zoology, Government Arts College (Autonomous) Kumbakonam 612 001, India). Macronutrient Analysis of Vermicompost Obtained from Organic Wastes, Press Mud and Cow Dung. Environment & Ecology 25S (3A) (2007): 891 – 894.

Soil parameters such as pH, N, P. and K present in the PSR (per cent substrate ratio) samples of vermicomposts obtained from press mud and cow dung before and after using them by the earthworm, *Lampito mauritii* were studied. The pH values of press mud samples obtained before vermicomposting showed, slightly acidic in nature; but after one month of vermicomposting, the levels showed somewhat basic or neutral. However, the pH levels of cow dung obtained before and after vermicomposting, though showed slightly high in higher PSR and completely neutral in lower PSR values, but no change in lower and a slight improvement in higher PSR were observed during vermicomposting. Though pH changes were noticed during vermicomposting, but their levels maintained at the safe range, 6 – 7. Over all, the levels of K present in both press mud and cow dung were relatively high when compared to N and P. The earthworm while composting, drastically lowered the levels of NPK in all the PSR over their values in raw samples except 20 and 15 PSR of cow dung, where a significant improvement was noticed in P levels. The decreased levels of NPK observed in the organic wastes revealed their effective decomposition when they pass through the gut of *Lampito mauritii*. Further the results of differential production of macro-nutrients also revealed that the organic wastes used in the current study are not equally accepted and processed by earthworms.

Keywords: Vermicompost, Macronutrient, Organic wastes, Pres mud, Cow dung.

Biopesticides

Indrani Karunasagar^a, M.M. Shivu^a, S.K. Girisha^a, G. Krohne^b and Iddya Karunasagar^a. (Department of Fishery Microbiology, Karnataka Veterinary, Animal and Fisheries Sciences University, College of Fisheries, Mangalore 575002, India, ^bDivision of Electron Microscopy, University of Wuerzburg, Biozentrum, Am Hubland 97074, Wuerzburg, Germany. Corresponding author. Tel./fax: +91 824 2246384). Biocontrol of pathogens in shrimp hatcheries using bacteriophages. Aquaculture, Volume 268(1-4) (2007): 288-292

Microflora associated with larval stages of shrimp could affect the health and development of the larvae. Some bacteria such as luminous *Vibrio harveyi* cause serious mortalities. Consequent to the ban on use of most antibiotics in aquaculture, there is a need for alternate technologies for control of bacterial pathogens. Bacteriophages have a potential to control bacterial pathogens. This paper reports isolation of lytic bacteriophages against *V. harveyi*. Four bacteriophages were isolated, three from oyster tissue and one from shrimp hatchery water. The bacteriophages lysed 55–70% of the 100 *V. harveyi* isolates tested. Two bacteriophages subjected to further study were found to belong to family *Siphoviridae* and were effective in reducing *V. harveyi* population in biofilm formed on high density polyethylene (HDPE) surface. In hatchery trials, bacteriophage treatment at 2×10^6 pfu ml⁻¹ level resulted in over 85% survival of *Penaeus monodon* larvae suggesting that bacteriophage therapy would be an effective alternative to antibiotics in shrimp hatcheries.

Keywords: *Penaeus monodon*; Bacteriophage; Biofilm; *Vibrio harveyi*

Petter Melin^{1, 2}, Ingvar Sundh¹, Sebastian Håkansson¹ and Johan Schnürer¹. (¹Department of Microbiology, Swedish University of Agricultural Sciences, P.O. Box 7025, Uppsala, 750 07, Sweden, ²School of Biology, University of Nottingham, University Park, Nottingham, NG7 2RD, UK. Petter Melin, Email: petter.melin@mikrob.slu.se). **Biological preservation of plant derived animal feed with antifungal microorganisms: safety and formulation aspects. Biotechnology Letters, Volume 29(8) (2007): 1147-1154**

During storage of moist animal feed, growth of detrimental fungi causing spoilage, or being mycotoxigenic or pathogenic, is a severe problem. Addition of biopreservative yeasts or lactic acid bacteria can significantly reduce this problem. However, their use requires several careful considerations. One is the safety to the animal, humans and the environment, tightly connected to legal aspects and the need for pre-market authorisation when supplementing feed with microorganisms. Although both yeasts and lactic acid bacteria are considered comparatively safe organisms due to low production of toxic metabolites, it is of great importance to understand the mechanisms behind the biopreservative abilities. Another important issue concerns practical aspects, such as the economic production of large amounts of the organisms and the development of a suitable formulation giving the organisms a long shelf life. These aspects are discussed and a recommendation of this review is that both safety and formulation aspects of a specific microbe should be considered at an early stage in the selection of new organisms with biopreservation potential.

Keywords: Biopreservation - Formulation - Lactic acid bacteria - Safety assessment - Yeasts

Analía Príncipe¹, Florencia Alvarez¹, Marina G. Castro¹, Lucía Zachi¹, Sonia E. Fischer¹, Gladys B. Mori¹ and Edgardo Jofré¹. (¹Facultad de Ciencias Exactas, Físico-Químicas y Naturales, Universidad Nacional de Río Cuarto, Ruta 36-Km 601-5800, Río Cuarto-Córdoba, Argentina. Corresponding author: Edgardo Jofré, Email: ejofre@exa.unrc.edu.ar). **Biocontrol and PGPR Features in Native Strains Isolated from Saline Soils of Argentina. Current Microbiology, Vol 55(4)(2007): 314-322.**

A bacterial collection of approximately one thousand native strains, isolated from saline soils of Cordoba province (Argentina), was established. From this collection, a screening to identify those strains showing plant growth promotion and biocontrol activities, as well as salt tolerance, was performed. Eight native strains tolerant to 1 M NaCl and displaying plant growth promotion and/or biocontrol features were selected for further characterization. Strains MEP₂ 18, MRP₂ 26, MEP₂ 11a, MEP₃ 1, and MEP₃ 3b significantly increased the growth of maize seedlings under normal and saline conditions, whereas isolates ARP₂ 3, AEP₁ 5, and ARP₂ 6 were able to increase the root dry weight of agropyre under saline conditions. On the other hand, strains MEP₂ 18 and ARP₂ 3 showed antagonistic activity against phytopathogenic fungi belonging to *Sclerotinia* and *Fusarium* genus. Antifungal activity was found in cell-free supernatants, and it was heat and protease resistant. Strains MEP₂18 and ARP₂3 were identified as *Bacillus* sp. and strains MEP₂11a and MEP₃3b as *Ochrobactrum* sp. according to the sequence analysis of 16S rRNA gene.

Dianne B.J. Taylor^{a, b}, Tim A. Heard^a, Quentin Paynter^{c, 1}, and Helen Spafford^b. (^aCooperative Research Centre for Australian Weed Management, CSIRO Entomology, 120 Meiers Road, Indooroopilly, Qld 4068, Australia, ^bUniversity of Western Australia School of Animal Biology, 35 Stirling Highway, Crawley, WA 6009, Australia, ^cCSIRO

Entomology, PMB 44, Winnellie NT 0822, Australia. Corresponding author. Address: Cooperative Research Centre for Australian Weed Management CSIRO Entomology, 120 Meiers Road, Indooroopilly, Qld 4068, Australia. Fax: +61 7 3214 2885. ¹ Present address: Landcare Research, Private Bag 92170 Auckland, New Zealand). Nontarget effects of a weed biological control agent on a native plant in Northern Australia. *Biological Control*, Volume 42(1) (2007): 25-33

Some weed biological control agents are released despite predictions that they might damage nontarget host plants in the field. Based on prerelease laboratory tests it was predicted that *Neurostrotta gunniella*, an agent released in Australia against *Mimosa pigra*, may occasionally use *Neptunia* spp. as hosts. However, due to high larval mortality on these species, *N. gunniella* was not expected to persist on *Neptunia* spp., nor have a significant effect on them. *N. gunniella* has established widely and is now abundant on the target weed, which grows sympatrically with at least one species of *Neptunia*. We investigated the nontarget attack of *Neptunia major* in the field, and the effect of that attack on plant growth and reproduction. Although an average of 61% of *N. major* plants growing adjacent to *M. pigra* thickets had evidence of *N. gunniella* attack, the intensity of attack was relatively low. At sites where *M. pigra* was not present, use of *N. major* plants by *N. gunniella* was noticeably reduced or absent. From glasshouse experiments, we determined that *N. gunniella* attack causes increased stem tip death and hinders plant growth in both plantlets and mature plants. At the highest level of attack recorded on *N. major* in the field, tip death increases by 54% and plant height would decrease by 6%. The effect of *N. gunniella* on the reproductive output of *N. major* could not be clearly resolved, but is likely to be small. Our findings support the predictions made during prerelease studies of *N. gunniella*.

Keywords: Host specificity; Host testing; *Mimosa pigra*; *Neptunia major*; *Neurostrotta gunniella*

A.J. Sosa^a, H.A. Cordo^a and J. Sacco^a. (^aUSDA, ARS, South American Biological Control Laboratory (SABCL), Bolivar 1559, (B1686EFA) Hurlingham, Argentina). Preliminary evaluation of *Megamelus scutellaris* Berg (Hemiptera: Delphacidae), a candidate for biological control of waterhyacinth. *Biological Control*, Volume 42(2) (2007): 129-138

The planthopper *Megamelus scutellaris* (Hemiptera: Delphacidae) is a potentially valuable insect for biological control of waterhyacinth (*Eichhornia crassipes* (Mart.) Solms.: Pontederiaceae), a serious aquatic weed in many tropical and subtropical countries. Field surveys done in South America revealed that this insect is sympatric with waterhyacinth throughout the native range of the plant, from Peru to as far south as Buenos Aires Province, Argentina. The host range of this insect was preliminarily evaluated, as was its ability to damage the plant, in order to determine whether further study was warranted. Feeding was compared, using a preference index, among leaf disks of test plants in two multiple-choice experiments: one with and one without members of the family Pontederiaceae. A similar no-choice experiment employed various species of Pontederiaceae along with rice and maize. A paired oviposition choice experiment was done by caging gravid females on *E. crassipes* and *Pontederia cordata* plants and then counting eggs deposited as well as oviposition scars. The ability of the insect to damage waterhyacinth was assessed in a greenhouse by inoculating a single waterhyacinth plant with none, 10, or 20 adult planthoppers. The planthopper effect was measured by comparing plant biomass (dry weight) among treatments after 1 month. All of these studies suggested that *M. scutellaris* is host specific and has the ability to damage waterhyacinth. Some feeding and development occurred on other species in the family Pontederiaceae which may have been laboratory artifacts, but which

mandates a cautious, further evaluation of this planthopper prior to its use as a classical biological control agent.

Keywords: *Megamelus scutellaris*; *Eichhornia crassipes*; Host specificity; Classical biological control

I.P. Furtado^{a, 1}, G.J. de Moraes^{a, b}, S. Kreiter^c, M.-S. Tixier^c and M. Knapp^d. (^aDepto. Entomologia, Fitopatologia e Zoologia Agricola, ESALQ-USP, 13418-900 Piracicaba, SP, Brazil, ^bCNPq Researcher, Brasilia, Brazil, ^cAgro.M/INRA, Unité d'Ecologie Animale et de Zoologie agricole, Laboratoire d'Acarologie, 34060 Montpellier Cedex 01, France, ^dInternational Centre of Insect Physiology and Ecology (ICIPE), P.O. Box 30772, 00100 Nairobi, Kenya. Corresponding author. Fax: +55 19 3429 4338. ¹ Depto. Ciências Físicas e Biológicas, URCA, 63100-000 Crato, CE, Brazil). Potential of a Brazilian population of the predatory mite *Phytoseiulus longipes* as a biological control agent of *Tetranychus evansi* (Acari: Phytoseiidae, Tetranychidae). **Biological Control, Volume 42(2) (2007): 139-147**

Tetranychus evansi Baker and Pritchard, is a key pest of tomato in Africa. Surveys have been conducted in the last few years to search for predators associated with this pest in Brazil for introduction into Africa. Biological parameters of *Phytoseiulus longipes* Evans, one of the predators found in those surveys, were evaluated when it was exposed to different food items, including *T. evansi*, in laboratory tests. The predator had about the same oviposition rate on *T. evansi* and on *Tetranychus urticae* Koch; it did not oviposit when fed on pollen of *Ricinus communis* L. or *Typha* sp. When given the choice, the predators were found in higher proportions on leaflets infested with *T. evansi* than with *T. urticae*; on the former leaflets, they also laid more eggs. Full life table analysis indicated that the predator performed well on *T. evansi* and on *T. urticae*, although reproductive parameters were higher on the former prey. The results suggest that the Brazilian population of *P. longipes* has a good potential as a biological control agent of *T. evansi*.

Keywords: *Phytoseiulus longipes*; *Tetranychus evansi*; *Tetranychus urticae*; Biological control

Alison J. Fisher^a, Dale M. Woods^b, Lincoln Smith^a and William L. Bruckart III^c. (^aUSDA, ARS, Exotic and Invasive Weeds Research Unit, Albany, CA 94710, USA, ^bCalifornia Department of Food and Agriculture, Sacramento, CA 95832, USA, ^cUSDA,ARS, Foreign Disease-Weed Science Research Unit, Fort Detrick, MD 21702, USA. Corresponding author. Fax: +1 510 559 5737). Developing an optimal release strategy for the rust fungus *Puccinia jaceae* var. *solstitialis* for biological control of *Centaurea solstitialis* (yellow starthistle). **Biological Control, Volume 42(2) (2007): 161-171**

The rust fungus *Puccinia jaceae* var. *solstitialis* (*P. j. solstitialis*) was first approved for release in California in 2003 as a classical biological control agent for *Centaurea solstitialis* (yellow starthistle, Asteraceae). It is difficult to produce large quantities of this obligate pathogen so it was necessary to develop an optimal release strategy for the efficient use of urediniospores. In 2005–2006 field experiments were conducted in two distinct habitats types, the coastal hills and Central Valley, CA, to determine the optimal month for introductions, and to determine if enclosing plots in tents at the time of inoculation was necessary to achieve high levels of infection. All releases resulted in infected plants at both sites for both years. At the Central Valley site near Woodland CA, disease incidence was higher than at the coastal hills, tent enclosures had no effect on infection, and the pathogen persisted throughout the growing season.

One year after the 2005 release, *P. j. solstitialis* had reappeared in most Central Valley plots, although early season releases in 2005 resulted in greater severity in 2006 than the late season releases. In the coastal hills near Napa, CA, tent enclosures improved disease incidence and severity after January and May releases, perhaps by retaining moisture, but the pathogen did not persist in all plots until plant senescence, and there was no reinfection (the following spring) at this site. The rust fungus did not have a negative affect on plant mortality, biomass, or flower production at either location. Our results show that infection can be achieved from January to June, and tent enclosures sometimes appeared to increase infection; however, reinfection is probably limited by local environmental conditions.

Keywords: *Puccinia jaceae* var. *solstitialis*; *Centaurea solstitialis*; Biological control; Rust fungus; Plant pathogen; California; Weed control

Heather A. Olson^a and D. Michael Benson^a. (Department of Plant Pathology, North Carolina State University, Raleigh, NC 27695, USA. Corresponding author. Fax: +1 919 515 5657). Induced systemic resistance and the role of binucleate *Rhizoctonia* and *Trichoderma hamatum* 382 in biocontrol of Botrytis blight in geranium. *Biological Control*, Volume 42(2) (2007): 233-241

Three root-colonizing fungi, binucleate *Rhizoctonia* (BNR) isolates BNR621 and P9023 and *Trichoderma hamatum* isolate 382 (T382), were studied for suppression of Botrytis blight in geranium by induction of host systemic resistance. Resistance to Botrytis blight was observed in geraniums transplanted into potting mix amended with formulations of P9023 and T382 2 weeks prior to inoculation with *Botrytis cinerea* when grown under environments either highly or less conducive to disease development. In the less conducive environment, P9023 and T382 provided protection equal to ($P < 0.0001$) the fungicide control. Specific stages in infection by *B. cinerea* were tested by counting germination of conidia in leaf extracts or by assessing lesion size in detached leaves taken from BNR- and T382-treated geraniums. No differences in conidial germination were observed. Lesion area results depended on time between application of inducing agents and detachment of leaves for inoculation. In geranium leaves detached and inoculated 7 days after topdressing with a Pesta formulation of BNR621 and P9023, AUDPC calculated from lesion area was smaller ($P < 0.0001$) than T382 and the inoculated control. Whereas, leaves detached and inoculated 14 days after topdressing with a formulation of T382 had a smaller ($P < 0.0001$) AUDPC from lesion area than plants treated with BNR621. Restriction of lesion development may play a role in the suppression of Botrytis blight in geranium. Our results may be the first to demonstrate induced systemic resistance by BNR fungi to a foliar pathogen and support additional research into use of T382 in an integrated management program for *B. cinerea*.

Keywords: Binucleate *Rhizoctonia*; *Trichoderma hamatum*; *Botrytis cinerea*; Geranium; Biological control; Induced resistance

Paola Pereira^{1, a}, Andrea Nesci^{2, a} and Miriam Etcheverry^{2, a}. (Orientación Ecología Microbiana, Departamento de Microbiología e Inmunología, Facultad de Ciencias Exactas, Físico-Químicas y Naturales, Universidad Nacional de Río Cuarto, Ruta Nacional 36 Km 601 (5800) Río Cuarto, Córdoba, Argentina. Corresponding author. Fax: +54 0358 4676231. ¹Fellow of Fondo para la Investigación Científica y Tecnológica (FONCyT), Argentina, ²Members of the Research Career of Consejo Nacional de Investigaciones Científicas y Técnicas). Effects of biocontrol agents on *Fusarium verticillioides* count and

fumonisin content in the maize agroecosystem: Impact on rhizospheric bacterial and fungal groups. *Biological Control*, Volume 42(3) (2007): 281-287

The present study tested the ability of *Bacillus amyloliquefaciens* and *Microbacterium oleovorans* to reduce *Fusarium verticillioides* populations and fumonisin accumulation in the maize agroecosystem. The impact of releasing these biocontrol agents on rhizospheric bacterial and fungal groups was also evaluated through isolation and identification of culturable microorganisms. When applied as seed coatings at a concentration of 10^7 CFU ml⁻¹ both agents were effective in reducing *F. verticillioides* counts and fumonisin B₁ and B₂ content from maize grains. Rhizospheric counts of the pathogen were also decreased by use of *B. amyloliquefaciens* at 10^7 CFU ml⁻¹. Richness and diversity indexes calculated for bacteria and fungi inhabiting the rhizosphere of maize remained unchanged following the addition of both biocontrol agents to seeds. Our research is being continued to further characterize the bacterial and fungal isolates with additional field assays.

Keywords: *Bacillus amyloliquefaciens*; *Microbacterium oleovorans*; *Fusarium verticillioides*; Biocontrol agents; Fumonisin; Maize; Richness; Diversity

F. Lemessa^a and W. Zeller^a (^aInstitute for Biological Control, Federal Biological Research Centre for Agriculture and Forestry (BBA), Heinrichstr. 243, 64287 Darmstadt, Germany. Corresponding author. Present address: Department of Crop Sciences, College of Agriculture and Veterinary Medicine, Jimma University, P.O. Box 307, Jimma, Ethiopia. Fax: +251 471110934). **Screening rhizobacteria for biological control of *Ralstonia solanacearum* in Ethiopia. *Biological Control*, Volume 42(3) (2007): 336-344**

Bacterial wilt caused by *Ralstonia solanacearum* (Smith) has become a severe problem mainly on potato and tomato in Ethiopia and no effective control measure is available yet. To explore possibilities for the development of biological control for the disease, 118 rhizobacteria, most of them collected from Ethiopia, were screened against an Ethiopian *R. solanacearum* strain. On the basis of *in vitro* screening, six strains (RP87, B2G, APF1, APF2, APF3, and APF4) with good inhibitory effect were selected for *in planta* testing in a greenhouse. In the greenhouse, soil and tomato seedlings were treated with the antagonists and their effects studied. The study showed that APF1 and B2G strains significantly reduced disease incidence and increased weight of tomato plants. Area under disease progress curves (AUDPC) was reduced by 60% and 56% in plants inoculated with APF1 and B2G strains, respectively. Plant dry weight increase in plants inoculated with APF1 and B2G strains was 96% and 75%, respectively. APF1 was found to be the most beneficial strain in disease suppression and also growth promotion resulting in 63% dry weight increase compared to untreated control. The study revealed that APF1 and B2G strains are promising strains whose effectiveness under field conditions and their mode of action should be investigated.

Keywords: Rhizobacteria; Biocontrol; Bacterial wilt; *Ralstonia solanacearum*; *Bacillus subtilis*; *Streptomyces setonii*; Fluorescent pseudomonads

T.R. Seastedt^a, D.G. Knochel^a, M. Garmoe^a and S.A. Shosky^a (^aDepartment of Ecology and Evolutionary Biology and Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309-0450, USA. Corresponding author. Fax: +1 303 492 6388). **Interactions and effects of multiple biological control insects on diffuse and spotted knapweed in the Front Range of Colorado. *Biological Control*, Volume 42(3) (2007): 345-354**

Abundances and interactions among biological control insects and their effects on target invasive plants were monitored within the flower heads and roots of diffuse knapweed, *Centaurea diffusa*, and in spotted knapweed, *Centaurea stoebe*, along the Colorado Front Range. Flower weevils, (*Larinus* species) and root-feeders (*Cyphocleonus achates* and *Sphenoptera jugoslavica*) were released on knapweed that already supported biological control gall flies (*Urophora* species). At a single monitoring site, seed production by *C. diffusa* declined from 4400 seeds m⁻² in 1997 to zero seeds m⁻² on the monitoring sites in 2006, while the flowering stem density of *C. diffusa* declined from a peak of almost 30 stems m⁻² in 2000 to zero stems m⁻² in 2006. The average abundance of *Urophora* and *Larinus* in flower heads fluctuated independently during the 2001–2006 interval, while the relative abundance of *C. achates* and *S. jugoslavica* in roots exhibited a weak inverse relationship that appeared driven by climate effects. The relative abundance of insects on a population of *C. stoebe* was monitored for five years as *Larinus* species and *C. achates* became established on spotted knapweed that already supported *Urophora* species. Spotted knapweed seed production on our monitoring site declined from 4600 seeds m⁻² in 2003 to zero seeds m⁻² in 2006. Unlike *C. diffusa*, substantial numbers of rosettes of *C. stoebe* remained present. *Larinus* consumed almost all *Urophora* encountered in *C. diffusa*, and consumed about 40% of the *Urophora* in co-infested flower heads of *C. stoebe* (ca. 10–15% of the total *Urophora* population). No negative correlations between the relative densities of flower head and root-feeding insects were observed. The effects of these insects on target plants have produced results consistent with the ‘cumulative stress hypothesis’ for biological control of *Centaurea* species.

Keywords: Biological control; Invasive plants; *Centaurea stoebe* L. ssp. *micranthos*; *Centaurea diffusa*; *Urophora affinis*; *Urophora quadrifasciata*; *Larinus minutus*; *Larinus obtusus*; *Cyphocleonus achates*; *Sphenoptera jugoslavica*

E. Gerber^a, H.L. Hinz^a and B. Blossey^b. (^aCABI Europe — Switzerland, Rue des Grillons 1, CH-2800 Delémont, Switzerland, ^bDepartment of Natural Resources, 202 Fernow Hall, Cornell University, Ithaca, NY 14853, USA). **Impact of the belowground herbivore and potential biological control agent, *Ceutorhynchus scrobicollis*, on *Alliaria petiolata* performance. *Biological Control*, Volume 42(3) (2007): 355-364**

We studied the influence of the root-crown weevil *Ceutorhynchus scrobicollis* on its host plant *Alliaria petiolata*, a European biennial herb that is currently invading much of temperate North America. Varying timing of attack and herbivore densities in a common garden allowed to assess seasonality of plant response, density-dependence of impact, and the effect of intraspecific competition on *C. scrobicollis* recruitment (number of F₁ generation adults emerged). Data collected in the common garden were compared with data collected at field sites. *C. scrobicollis* is a common weevil in Europe, frequently attaining high attack levels on its host plant. In the common garden, weevil attack decreased plant survival by up to 43%, reduced plant height by 54%, increased the number of shoots by up to four-fold and delayed seed ripening, but had no significant negative effect on seed production. Plants infested in spring allocated less biomass to aboveground plant parts, and remained smaller than plants attacked in autumn, indicating that the latter were able to partly compensate for weevil attack. Increasing weevil density rarely had an effect on *A. petiolata* performance, and did not increase F₁ recruitment, suggesting strong intraspecific competition. At field sites, *C. scrobicollis* attack is spread over a long time period, which probably alleviates intraspecific competition. In summary, attack by the root-crown feeding weevil, *C. scrobicollis*, can substantially reduce growth and survival of *A. petiolata*. If

introduced as a biological control agent into North America, *C. scrobicollis* is likely to decrease the fitness and competitive superiority of *A. petiolata*.

Keywords: *Alliaria petiolata*; Biological control; *Ceutorhynchus scrobicollis*; Density-dependence; Efficacy assessment; Intraspecific competition; Plant–herbivore interaction; Timing of attack

Teja Tschardtke^a, Riccardo Bommarco^b, Yann Clough^a, Thomas O. Crist^c, David Kleijn^d, Tatyana A. Rand^e, Jason M. Tylianakis^f, Saskya van Nouhuys^{g, h} and Stefan Vidalⁱ. (^aAgroecology, University of Göttingen, Waldweg 26, 37073 Göttingen, Germany, ^bDepartment of Ecology, Swedish University of Agricultural Sciences, P.O. Box 7044, SE-750 07 Uppsala, Sweden, ^cDepartment of Zoology, Miami University, Oxford, OH 45056, USA, ^dAlterra, Centre for Ecosystem Studies, Droevendaalsesteeg 3, P.O. Box 47, 6700 AA, Wageningen, The Netherlands, ^eSchool of Biological Sciences, University of Nebraska, Lincoln, NE 68588-0118, USA, ^fSchool of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch 8020, New Zealand, ^gDepartment of Ecology and Evolutionary Biology, Cornell University, E145 Corson Hall Ithaca, NY 14853-2701, USA, ^hDepartment of Biological and Environmental Sciences, University of Helsinki, 00014-FIN, Finland, ⁱAgricultural Entomology, University of Göttingen, Grisebachstrasse 6, 37077 Göttingen, Germany. Corresponding author. Fax: +49 551 398806.). Conservation biological control and enemy diversity on a landscape scale. *Biological Control*, Volume 43(3) (2007): 294-309

Conservation biological control in agroecosystems requires a landscape management perspective, because most arthropod species experience their habitat at spatial scales beyond the plot level, and there is spillover of natural enemies across the crop–noncrop interface. The species pool in the surrounding landscape and the distance of crop from natural habitat are important for the conservation of enemy diversity and, in particular, the conservation of poorly-dispersing and specialized enemies. Hence, structurally complex landscapes with high habitat connectivity may enhance the probability of pest regulation. In contrast, generalist and highly vagile enemies may even profit from the high primary productivity of crops at a landscape scale and their abundance may partly compensate for losses in enemy diversity. Conservation biological control also needs a multitrophic perspective. For example, entomopathogenic fungi, plant pathogens and endophytes as well as below- and above-ground microorganisms are known to influence pest-enemy interactions in ways that vary across spatiotemporal scales. Enemy distribution in agricultural landscapes is determined by beta diversity among patches. The diversity needed for conservation biological control may occur where patch heterogeneity at larger spatial scales is high. However, enemy communities in managed systems are more similar across space and time than those in natural systems, emphasizing the importance of natural habitat for a spillover of diverse enemies. According to the insurance hypothesis, species richness can buffer against spatiotemporal disturbances, thereby insuring functioning in changing environments. Seemingly redundant enemy species may become important under global change. Complex landscapes characterized by highly connected crop–noncrop mosaics may be best for long-term conservation biological control and sustainable crop production, but experimental evidence for detailed recommendations to design the composition and configuration of agricultural landscapes that maintain a diversity of generalist and specialist natural enemies is still needed.

Keywords: Agroecosystems; Beta diversity; Dispersal; Habitat fragmentation; Insurance hypothesis; Multitrophic interactions; Parasitoid and predator spillover; SLOSS; Spatial ecology; Specialists vs. generalists; Sustainability

Jinghong Zhang^a, Xu Zhang^a, Yongqing Ni^a, Xiaojuan Yang^a and Hongyu Li^{a*} (^aMOE Key Laboratory of Arid and Grassland Ecology, School of Life Science, Lanzhou University, Lanzhou 73000, China. Corresponding author. Tel.: +86 931 8912560; fax: +86 931 8912561). **Bioremediation of arsenic from medicinal realgar by pure and mixed cultures. Process Biochemistry, Volume 42(9) (2007): 1265-1271**

The aim of this paper is to determine the efficiency of bioleaching of arsenic in realgar, a Chinese mineral drug, using pure cultures of *Acidithiobacillus ferrooxidans* or *Acidithiobacillus thiooxidans* and a mixed culture of *A. ferrooxidans* and *A. thiooxidans*. The experiments were carried out in shaker flasks, at 150 rpm, 30 °C at a culture pH of 1.80. To investigate the mechanism of the bioleaching in realgar, media with and without ferrous iron were chosen for the experiments. The results showed that the leaching rate of arsenic in realgar after 20 days was higher (43%) in *A. ferrooxidans* cultures with ferrous iron compared to cultures without ferrous iron (10%), and the leaching rate of *A. thiooxidans* cultures only increased from 21% to 23% in the presence of ferrous iron. The leaching rate of arsenic in mixed culture with ferrous iron was greatly enhanced from 16% to 56%, indicating that bioleaching in mixed culture is preferable for the dissolution of realgar.

Keywords: *Acidithiobacillus ferrooxidans*; *Acidithiobacillus thiooxidans*; Realgar; Bioleaching; Chinese mineral medicine

Mausam Verma¹, Satinder K. Brar¹, Rajeshwar Dayal Tyagi¹, Rao Y. Surampalli² and Jose R. Valero¹. (¹INRS-ETE, Université du Québec, 490, Rue de la Couronne, Quebec, Canada, G1K 9A9, ²US EPA, P. O. Box-17-2141, Kansas, KS 66117, USA. Rajeshwar Dayal Tyagi, Email: tyagi@ete.inrs.ca). **Industrial wastewaters and dewatered sludge: rich nutrient source for production and formulation of biocontrol agent, *Trichoderma viride*. World Journal of Microbiology and Biotechnology, Volume 23(12) (2007): 1695-1703**

Axenic cultivation of biocontrol fungus *Trichoderma viride* was conducted on a synthetic medium and different wastewaters and wastewater sludges in shake flasks to search for a suitable raw material resulting in higher biocontrol activity. Soluble starch based synthetic medium, dewatered municipal sludge, cheese industry wastewater sludge, pre-treated and untreated pulp and paper industry wastewater and slaughter house wastewater (SHW) were tested for *T. viride* conidia and protease enzyme production. The maximum conidia production followed the order, soluble starch medium ($>10^9$ c.f.u./mL), untreated pulp and paper industry wastewater (4.9×10^7 c.f.u./mL) > cheese industry wastewater (1.88×10^7 c.f.u./mL) \approx SHW (1.63×10^7 c.f.u./mL) > dewatered municipal sludge (3.5×10^6 c.f.u./mL) > pre-treated pulp and paper industry wastewater (1.55×10^6 c.f.u./mL). The protease activity of *T. viride* was particularly higher in slaughterhouse wastewater (2.14 IU/mL) and dewatered municipal sludge (1.94 IU/mL). The entomotoxicity of soluble starch based synthetic medium was lower (≈ 6090 SBU/ μ L) in contrast to other raw materials. The entomotoxicity inversely decreased with carbon to nitrogen ratio in the growth medium and the conidia concentration and protease activity also contributed to the entomotoxicity. The residual c.f.u./g formulation of *T. viride* conidia were up to approximately, 90% after 1 month at 4 ± 1 °C and about 70% after 6 months

at 25 ± 1 °C. Thus, production of *T. viride* conidia would help in marketability of low cost biopesticide from the sludge and safe reduction of pollution load.

Keywords: Biocontrol - Conidia - Entomotoxicity - *Trichoderma viride* - Wastewater - Sludge

Biodegradation

Daisuke Baba^a and Arata Katayama^{a, b}. (^aGraduate School of Engineering, Nagoya University, Furo-cho, Chikusa, Nagoya 464-8603, Japan, Division of Integrated Research Projects, EcoTopia Science Institute, Nagoya University, Furo-cho, Chikusa, Nagoya 464-8603, Japan. Corresponding author. phone: +81-(0)52-789-5856 fax: +81-(0)52-789-5857) **Enhanced anaerobic biodegradation of polychlorinated biphenyls in burnt soil culture. Journal of Bioscience and Bioengineering, Volume 104(1) (2007): 62-68**

Anaerobic microbial degradation of polychlorinated biphenyls (PCBs) in Kanechlors-300 and -400 was enhanced significantly by adding burnt soil originally obtained from an uncontaminated paddy soil to the microbial culture. The maximum PCB-degrading activity was 0.49 nmol-Cl/ml-culture/day (238 ng-total-PCBs/ml-culture/day), where the degradation was observed in most of the congeners in Kanechlors-300 and -400: not only in *meta*- and *para*-substituted congeners but also *ortho*-substituted congeners. The degradation of PCBs occurred during the increase in the microbial population with acetate as the main electron donor. The ratio between the consumption of electron donors and the dechlorination of PCBs was revealed to be 93.9 nmol-Cl/mmol-e-donor, which is also the dechlorination efficiency over 56 d of incubation. The addition of acetate and lactate several times into the culture rejuvenated the activity.

Key words: anaerobic degradation; polychlorinated biphenyls; microbial consortium; dechlorination; rejuvenation; Kanechlor

David Schleheck,^{1,2} Thomas P. Knepper,³ Peter Eichhorn,⁴ and Alasdair M. Cook^{1*} (Department of Biology, The University of Konstanz, D-78457 Konstanz, Germany,¹ School of Biotechnology and Biomolecular Sciences and Centre for Marine Biofouling and BioInnovation, University of New South Wales, Sydney, NSW 2052, Australia,² Europa Institute of Applied Sciences Fresenius, D-65510 Idstein, Germany,³ State University of New York at Buffalo, Buffalo, New York 14260⁴. * Corresponding author. Mailing address: Department of Biology, The University of Konstanz, Universitätsstr. 10, D-78457 Konstanz, Germany. Phone: (49) 7531 88 4247. Fax: (49) 7531 88 2966. E-mail: alasdair.cook@uni-konstanz.de. [▽] Published ahead of print on 8 June 2007. [†] Supplemental material for this article may be found at <http://aem.asm.org/>). ***Parvibaculum lavamentivorans* DS-1^T Degrades Centrally Substituted Congeners of Commercial Linear Alkylbenzenesulfonate to Sulfophenyl Carboxylates and Sulfophenyl Dicarboxylates^{▽,†}. Applied and Environmental Microbiology, Vol. 73(15) (2007): 4725-4732.**

Commercial linear alkylbenzenesulfonate (LAS) contains 20 congeners of linear alkanes (C₁₀ to C₁₃) substituted subterminally with the 4-sulfophenyl moiety in any position from lateral to central. *Parvibaculum lavamentivorans* DS-1^T degrades each of eight laterally substituted congeners [e.g., 2-(4-sulfophenyl)decane (2-C₁₀-LAS); herein, compounds are named

systematically by chain length (e.g., C₁₀) and by the position of the substituent on the chain (e.g., position 2)] to a major sulfophenyl carboxylate [SPC; here 3-(4-sulfophenyl)butyrate (3-C4-SPC)] and two minor products, namely, the α,β -unsaturated SPC (SPC-2H, here 3-C4-SPC-2H) and the SPC+2C (here 5-C6-SPC) species (D. Schleheck, T. P. Knepper, K. Fischer, and A. M. Cook, Appl. Environ. Microbiol. 70:4053-4063). The degradation of centrally substituted congeners by strain DS-1 was examined in this work. 5-C10-LAS yielded not only the predicted 4-C8-SPC, 4-C8-SPC-2H, and 6-C10-SPC (about 70% of products) but also sulfophenyl dicarboxylates (SPdC), i.e., C6-, C8-, and C10-SPdC. These were identified by electrospray ionization-mass spectrometry (ESI-MS) after separation by high-pressure liquid chromatography (HPLC). ESI ion-trap MS and ESI-time of flight-MS were used to confirm the identities of key intermediates. Different mixtures of congeners obtained by separation of commercial LAS by HPLC were degraded, and the degradative products were compared. If a congener carried the sulfophenyl substituent on the 5, 6, or 7 position, SPdCs were formed as well as SPC, SPC-2H, and SPC+2C, whereas the substituent on the 2, 3, or 4 position yielded only SPC, SPC-2H, and SPC+2C. Some 50 products were generated from the 20 LAS congeners: 11 major SPCs, each with an SPC-2H and an SPC+2C (i.e., 33 SPC and SPC-2H species), and about 17 SPdC species. A large array of compounds, many in low quantities, is thus generated by *P. lavamentivorans* DS-1 during the degradation of commercial LAS.

B. Kolvenbach,¹ N. Schlaich,² Z. Raoui,^{1,2} J. Prell,³ S. Zühlke,⁴ A. Schäffer,¹ F. P. Guengerich,⁵ and P. F. X. Corvini^{6*}. (Department of Environmental Research, Rheinisch-Westfälische Technische Hochschule (RWTH), Aachen University, D-52074 Aachen, Germany,¹ Department of Plant Physiology, RWTH Aachen University, D-52074 Aachen, Germany,² School of Biological Sciences, University of Reading, Reading, Berkshire RG6 6AJ, United Kingdom,³ Institute of Environmental Research (INFU), University of Dortmund, D-44221 Dortmund, Germany,⁴ Department of Biochemistry and Center in Molecular Toxicology, Vanderbilt University School of Medicine, Nashville, Tennessee 37232-0146,⁵ Institute for Ecopreneurship, University of Applied Sciences Northwestern Switzerland, CH-4132 Muttenz, Switzerland⁶. * Corresponding author. Mailing address: Institute for Ecopreneurship, School of Life Sciences, University of Applied Sciences Northwestern Switzerland, Gründenstrasse 40, CH-4132 Muttenz, Switzerland. Phone: 41 61 467 4344. Fax: 41 61 467 4290. E-mail: philippe.corvini@fnw.de). **Degradation Pathway of Bisphenol A: Does *ipso* Substitution Apply to Phenols Containing a Quaternary α -Carbon Structure in the *para* Position?** ^V ^T. Applied and Environmental Microbiology, Vol. 73(15) (2007): 4776-4784.

The degradation of bisphenol A and nonylphenol involves the unusual rearrangement of stable carbon-carbon bonds. Some nonylphenol isomers and bisphenol A possess a quaternary α -carbon atom as a common structural feature. The degradation of nonylphenol in *Sphingomonas* sp. strain TTNP3 occurs via a type II *ipso* substitution with the presence of a quaternary α -carbon as a prerequisite. We report here a new degradation pathway of bisphenol A. Consequent to the hydroxylation at position C-4, according to a type II *ipso* substitution mechanism, the C-C bond between the phenolic moiety and the isopropyl group of bisphenol A is broken. Besides the formation of hydroquinone and 4-(2-hydroxypropan-2-yl)phenol as the main metabolites, further compounds resulting from molecular rearrangements consistent with a carbocationic intermediate were identified. Assays with resting cells or cell extracts of *Sphingomonas* sp. strain TTNP3 under an ¹⁸O₂ atmosphere were performed. One atom of ¹⁸O₂ was present in hydroquinone, resulting from the monooxygenation of bisphenol A and nonylphenol. The

monooxygenase activity was dependent on both NADPH and flavin adenine dinucleotide. Various cytochrome P450 inhibitors had identical inhibition effects on the conversion of both xenobiotics. Using a mutant of *Sphingomonas* sp. strain TTNP3, which is defective for growth on nonylphenol, we demonstrated that the reaction is catalyzed by the same enzymatic system. In conclusion, the degradation of bisphenol A and nonylphenol is initiated by the same monooxygenase, which may also lead to *ipso* substitution in other xenobiotics containing phenol with a quaternary α -carbon.

Jonathan S. Schilling^a and Jody Jellison^b. (^aDepartment of Bioproducts and Biosystems Engineering, University of Minnesota, St. Paul, MN 55108, USA, ^bDepartment of Biological Sciences, University of Maine, Orono, ME 04469, USA. Corresponding author. Tel.: +1 612 624 1761; Fax: +1 612 625 6286). Extraction and translocation of calcium from gypsum during wood biodegradation by oxalate-producing fungi[✉] International Biodeterioration & Biodegradation, Volume 60(1) (2007): 8-15

Dry rot fungi are a unique group of brown rot fungi, capable of decaying wood at a distance from soil and moisture sources. When degrading wood in the built environment, these fungi are typically observed in contact with calcium (Ca)-containing materials, but it is unclear how or if this association benefits the fungus. In this work, several wood-degrading fungi, including two dry rot species, were cultured for 10 weeks in agar-block microcosms containing spruce heartwood and a Ca treatment. Calcium treatments were gypsum blocks (>99% pure CaSO₄) or 2 mM CaCl₂ in agar. Controls contained no Ca addition. Scanning electron microscopy and microanalysis confirmed hyphal contact with gyp-board and verified Ca oxalate crystal formation. Cation analysis revealed net Ca enrichment in wood degraded in the presence of gyp-board, including wood degraded by a white rot fungus. Despite wood Ca enrichment in gypsum treatments, wood weight loss and pH were unaffected, while acid-extractable oxalate was often higher. This suggests that Ca extracted from materials by wood decay fungi affects oxalate solubility, but does not necessarily facilitate wood decay. This dynamic should, however, be explored in relation to other building material elements and during incipient decay.

[✉]*Scientific Relevance:* This work explores the theory that fungi, particularly the 'dry rot' fungi, actively import calcium ions during wood decay. Dry rot fungi are a severe problem in the built environment, often inhabiting nutrient poor environments such as attics. Calcium imported from building materials may help neutralize excess oxalate in the absence of soil calcium, but this remains unclear from previous research.

Keywords: Dry rot; Brown rot; Oxalic acid; Masonry; Biodeterioration

Ana Begonja Kolar^a, Dubravka Hršak^a, Sanja Fingler^b, Helena Četković^c, Ines Petrić^a and Nikolina Udiković Kolić^a. (^aDivision for Marine and Environmental Research, Ruđer Bošković Institute, POB 180, HR 10002 Zagreb, Croatia, ^bInstitute for Medical Research and Occupational Health, Zagreb, POB 291, HR 10001 Zagreb, Croatia, ^cDivision of Molecular Biology, Ruđer Bošković Institute, Zagreb, POB 180, HR 10002 Zagreb, Croatia. Corresponding author. Tel.: +38514680944; fax: +38514680242). PCB-degrading potential of aerobic bacteria enriched from marine sediments. International Biodeterioration & Biodegradation, Volume 60(1) (2007): 16-24

The main objective of this work was to study catabolic potential of marine sediment bacteria in aerobic degradation of polychlorinated biphenyls (PCBs). Marine sediment samples were

collected at urban areas of the Croatian Adriatic coast, and microcosm enrichment experiments were performed in seawater mineral salts (SMS) medium with the addition of biphenyl as the only carbon source. After two to four subcultures, all enriched mixed cultures demonstrated the capability to use biphenyl, indicating that biphenyl-utilizing bacteria are widespread in coastal marine sediments. PCB-degrading activity of the enrichment cultures as well as that of their biphenyl-utilizing members were further studied in SMS medium with the addition of PCB mixtures containing di- to heptachlorinated congeners. GC-MS analyses of the extracted cultures suggested that, although they differed in PCB-degrading capabilities, all of the enrichment cultures expressed activity toward at least some of the lower chlorinated congeners (di- to tetrachlorobiphenyls). Biphenyl-utilizing bacteria isolated from the most active PCB-degrading mixed cultures showed little taxonomic diversity (six out of seven isolates belonged to the genus *Rhodococcus* and one to the genus *Sphingomonas*). All isolated *Rhodococcus* strains (*R. erythropolis* and *R. ruber*) showed substantial PCB-degrading activity, suggesting that these bacteria might play an important role in aerobic PCB degradation in polluted marine sediment.

Keywords: Marine sediment; PCB; PCB degradation; *Rhodococcus*

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***Scientific relevance of paper:* Increase understanding of the preventive effect of biocides and water repellent substances on microbial colonization of mortars. Corresponding author. Tel.: +39 90 6765196; fax: +39 90 392733). Evaluation of the efficiency of water-repellent and biocide compounds against microbial colonization of mortars ✉ International Biodeterioration & Biodegradation, Volume 60(1) (2007): 25-34**

Mortars are building material with a high primary bioreceptivity and thus, they are easily colonized by different microorganisms. To reduce this problem, especially if it concerns restoration and conservation of works of art, water repellents and biocides can be applied alone or in combination. This paper describes experimental data carried out in laboratory conditions as well as outdoors with artificially infected mortars to reproduce natural colonization. The effects of three hydrophobic compounds (RHODORSIL RC80, HYDROPHASE SUPERFICI and HYDROPHASE MALTE) applied alone or in combination with the biocide ALGOPHASE and with the new water miscible formulation (ALGOPHASE PH025/d) were studied. Effectiveness was compared with the behavior of untreated mortars.

In both types of experiments, it was clearly shown that water repellents alone do not stop microbial colonization, while water repellents plus biocides prevent microbial growth.

In addition, it was shown under indoor and outdoor conditions that fungi are able to colonize untreated mortars as well as those treated only with hydrophobic compounds before phototrophic microorganisms. No significant differences were observed among the compounds tested in their efficacy in preventing colonization.

Keywords: Biocides; Water repellents; Microbial colonization; Mortars; Bioreceptivity

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kinetic of the effluent derived from the anaerobic digestion of two-phase olive mill solid residue. *International Biodeterioration & Biodegradation*, Volume 60(1) (2007): 60-67

Aerobic biodegradability of the effluent derived from the anaerobic digestion of two-phase olive mill solid residue was assessed in laboratory-scale batch reactors of 1.5-l volume. Five experimental runs at influent substrate concentrations in the range of 660–13100 mg COD l⁻¹ were carried out at a ratio of substrate-to-microorganisms concentration S_0/X_0 equal to unity. Chemical oxygen demand (COD), soluble chemical oxygen demand (SCOD), volatile suspended solids of the mixed liquor (MLVSS), pH, dissolved oxygen, saturation percentage (% sat.) and temperature were determined during the experiments. An increase in the influent substrate concentration caused a decrease in COD and SCOD removals at similar times of aeration θ . The non-biodegradable fractions of COD and SCOD were determined to be 43.1% and 53.1% of their initial values, respectively. It was found that a first-order kinetics adequately described the variation of biodegradable SCOD with θ . The values of the first-order reaction constants were found to be 0.074, 0.044, 0.040, 0.033, and 0.013 h⁻¹ (1.776, 1.056, 0.960, 0.792, and 0.312 d⁻¹) for Runs 1–5, respectively, with variance coefficients lower than 10% in all cases. During the experiments the growth of microorganisms appeared to be in the exponential phase. Hence, first-order reactions were assumed to describe the increase in MLVSS concentration with θ . The values of the specific growth rate μ were determined to be: 0.0064, 0.0075, 0.0084, 0.0091, and 0.0038 h⁻¹ (0.154, 0.180, 0.202, 0.218, and 0.091 d⁻¹) for initial substrate concentrations of 660 (Run 1), 1400 (Run 2), 2600 (Run 3), 6600 (Run 4), and 13100 (Run 5) mg COD l⁻¹, respectively. Finally, the values of the maximum specific growth rate μ_M and the saturation constant K_S of the Monod equation with their standard deviations ($p < 0.05$) were determined to be 0.23 ± 0.01 d⁻¹ and 160 ± 8 mg SCOD l⁻¹, respectively.

Keywords: Aerobic biodegradability; Batch process; Effluent from anaerobic digestion; Kinetics; Two-phase olive mill solid residue

Stanislav Vinopal^a, Tomas Ruml^a and Pavel Kotrba^a. (^aDepartment of Biochemistry and Microbiology, Institute of Chemical Technology, Technická 3, 166 28 Prague, Czech Republic. Corresponding author. Tel.: +420 220445134; fax: +420 220445167). Biosorption of Cd²⁺ and Zn²⁺ by cell surface-engineered *Saccharomyces cerevisiae*. *International Biodeterioration & Biodegradation*, Volume 60(2) (2007): 96-102

The carboxyl-terminal part of sexual adhesion glycoprotein α -agglutinin (AG α 1Cp) was employed as an anchoring domain for surface display of short metal binding peptides of sequences N-Ser-(Gly-Cys-Gly-Cys-Pro-Cys-Gly-Cys)₂-Gly-C (CP2 peptide) and N-Ser-(Gly-His-His-Pro-His)₃-Gly-C (HP3 peptide) in the cell wall of potential biosorbent *Saccharomyces cerevisiae*. The constructed genetic fusions were efficiently expressed and found covalently attached to cell wall glucan and both O- and N-glycosylated. As a consequence of AG α 1Cp overexpression the nitrogen content of cell wall increased by 30%, which was reflected by increased sorption capacity of both isolated cell walls and intact cells. Compared to parental cells, the surface display of mere anchoring domain doubled the amount of Cd²⁺ and Zn²⁺ adsorbed by modified biomass from solutions containing 10 to 200 μ M metal ions. Displayed CP2 and HP3 sequences showed selectivity towards Cd²⁺ and Zn²⁺, respectively. The fusion of CP2 peptide to AG α 1Cp sequence increased Cd²⁺ sorption by 30%, whilst accumulation of Zn²⁺ remained unaffected. The HP3 sequence, shown to form 3 high-affinity Zn²⁺ binding sites with apparent dissociation constant of 1.2×10^{-7} , increased capability of engineered strain to adsorb

Zn²⁺ by 20% but did not contribute to Cd²⁺ sorption. The Scatchard analysis of metal adsorption data suggest that the expression of AGa1Cp variants in *S. cerevisiae* increased the number of high-affinity covalent ligand–metal interactions, thereby enhancing metal recovery at low external concentrations. In addition, glycosylation of anchoring domain by polymannans, presumably phosphorylated, was likely to increase the ion-exchange capacity of modified biosorbent, which became effective at higher metal concentrations.

Keywords: Yeast biosorbent; α -agglutinin; Cell surface display; Metal-binding peptide

Cuiying Jia¹, Ruijuan Kang¹, Yuhui Zhang², Yong Zhang¹ and Wei Cong¹. (¹State Key Laboratory of Biochemical Engineering, Institute of Process Engineering, Chinese Academy of Sciences, P.O. Box 353, Beijing, 100080, People's Republic of China, ²Department of Botany, Henna Agricultural University, Zhengzhou , 450002, People's Republic of China. Wei Cong, Email: weicong@sohu.com). **Degradation and decolorization of monosodium glutamate wastewater with *Coriolus versicolor*. *Biodegradation*, Volume 18(5) (2007): 551-557**

Degradation and decolorization of monosodium glutamate wastewater (MSGW) with *Coriolus versicolor* were firstly carried out. The effects of various operation parameters namely wastewater concentrations, pH, culture time and incidence of sterilization on maximum percentage of degradation and decolorization of wastewater were investigated. Studies of mycelium and enzyme for *C. versicolor* degradation and decolorization were estimated in this study. Ten percentage of wastewater concentration and pH = 5.0 were found to be the most suitable ones among the other experiments. The highest degradation and decolorization efficiency of wastewater was obtained at the fifth day of cultivation, which was displayed with more than 70% chemical oxygen demand removal, 83% total sugar removal and 55% color removal, respectively. Sterile operation had no remarkable effect on the degradation and decolorization efficiency for *C. versicolor*. Mycelium and the extra cellular fungal enzyme were both necessary for the degradation and decolorization of MSGW. *C. versicolor* possesses great potential and economic advantages in MSGW treatment.

Keywords: Degradation - Decolorization - *Coriolus versicolor* - Monosodium glutamate wastewater

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Biosorption is an effective means of removal of heavy metals from wastewater. In this work the biosorption behavior of *Cladophora fascicularis* was investigated as a function of pH, amount of biosorbent, initial Cu²⁺ concentration, temperature, and co-existing ions. Adsorption equilibria were well described by Langmuir isotherm models. The enthalpy change for the biosorption process was found to be 6.86 kJ mol⁻¹ by use of the Langmuir constant *b*. The biosorption process was found to be rapid in the first 30 min. The presence of co-existing cations such as Na⁺, K⁺, Mg²⁺, and Ca²⁺ and anions such as chloride, nitrate, sulfate, and acetate did not significantly affect uptake of Cu²⁺ whereas EDTA substantially affected adsorption of the metal.

When experiments were performed with different desorbents the results indicated that EDTA was an efficient desorbent for the recovery of Cu^{2+} from biomass. IR spectral analysis suggested amido or hydroxy, C=O, and C–O could combine strongly with Cu^{2+} .

Keywords: Biosorption - Enthalpy of biosorption - Copper(II) - Marine algae - Wastewater

Jose A. Perales¹, Manuel A. Manzano¹, M. Carmen Garrido¹, Diego Sales¹ and Jose M. Quiroga¹. (¹Area of Environmental Technologies, Faculty of Marine and Environmental Sciences, University of Cadiz, Campus de Puerto Real, Polígono Río San Pedro s/n, 11500 Puerto Real, Cadiz, Spain. Jose A. Perales, Email: joseantonio.perales@uca.es). **Molecular structure and biodegradation kinetics of linear alkylbenzene sulphonates in sea water. *Biodegradation*, Volume 18(5) (2007): 567-578**

The present paper describes the results of the application of the biodegradation test proposed by the United States Environmental Protection Agency (USEPA) “Biodegradability in sea water” Office of Prevention, Pesticides, and Toxic Substances (OPPTS) 835.3160, to Linear Alkylbenzene Sulphonate (LAS), the synthetic surfactant with the highest consumption volume on a world-wide basis. High performance liquid chromatography (HPLC) has been employed for the separation and quantification of the different homologues and isomers of the surfactant. Water from the Bay of Cádiz (South–West of the Iberian peninsula) has been used as test medium. The results indicate how both lag and t_{50} time shows a significant linear relationship with the length of the alkyl chain of the homologue; the effect of this is that the homologues of longer chain length not only begin to degrade first but also degrade at a faster rate. Regarding the isomeric composition, it is observed that as the percentage of biodegradation increases, there is an increase in the proportion of internal isomers, in comparison with the isomeric relationships of the original test substance

Keywords: Biodegradation - Surfactant - Linear alkylbenzenesulfonate - Molecular structure - Kinetic - Isomeric composition - Bay of Cádiz

Min Tseng¹, Kim-Chi Hoang², Mei-Kwei Yang³, Shu-Feng Yang¹ and Wen Shen Chu¹. (¹Bioresource Collection and Research Center, Food Industry Research and Development Institute, 331, Shih-Ping Rd., Hsinchu, 300, Taiwan, ROC, ²Department of Chemical and Material Engineering, Ta-Hwa Institute of Technology, 1, Ta-Hwa Road, Chiung-Lin, Hsinchu, 30743, Taiwan, ROC, ³Department of Life Science, Fu Jen Catholic University, 510 Chun Cheng Rd. Hsinchuang, Taipei, 242, Taiwan, ROC. Kim-Chi Hoang, Email: chi@thit.edu.tw). **Polyester-degrading thermophilic actinomycetes isolated from different environment in Taiwan. *Biodegradation*, Volume 18(5) (2007): 579-583.**

Thermophilic actinomycetes strains were isolated from various environment in Taiwan and screened for degradation of poly(ethylene succinate) (PES), poly(ϵ -caprolactone) (PCL) and/or poly(β -hydroxybutyrate) (PHB) by the clear-zone method. Out of 341 strains of thermophilic actinomycetes, 105 isolates were PHB-degraders (30.8%), 198 isolates were PCL-decomposers (58.1%), and 99 isolates could degrade PES (29.0%). Furthermore, 77 isolates could degrade both PHB and PCL (22.6%), 35 isolates could degrade both PHB and PES (10.3%), 81 isolates could degrade both PES and PCL (23.8%) and 31 isolates could degrade the three polyesters used in this study (9.1%). Base on the morphological and chemical characteristics, these 31 isolates belonging to *Actinomadura* (12.9%), *Microbispora* (25.8%), *Streptomyces* (48.4%), *Thermoactinomyces* (9.7%) and *Saccharomonospora* genus (3.22%).

Keywords: Thermophile actinomycetes - Microbial degradation - Polyester - Environment

Sugima Rappert¹, Renjie Li¹, Mariya Kokova¹, Mathias Antholz¹, Stephanie Nagorny², Wittko Francke² and Rudolf Müller¹. (¹Institute of Technical Biocatalysis, Technical University Hamburg-Harburg, Denickestr. 15, 21071 Hamburg, Germany, ²Institute of Organic Chemistry, University of Hamburg, Martin Luther King Platz 6, 20146 Hamburg, Germany. Rudolf Müller, Email: ru.mueller@tu-harburg.de). **Degradation of 2,5-dimethylpyrazine by *Rhodococcus erythropolis* strain DP-45 isolated from a waste gas treatment plant of a fishmeal processing company. *Biodegradation*, Volume 18(5) (2007): 585-596.**

A bacterium, strain DP-45, capable of degrading 2,5-dimethylpyrazine (2,5-DMP) was isolated and identified as *Rhodococcus erythropolis*. The strain also grew on many other pyrazines found in the waste gases of food industries, like 2,3-dimethylpyrazine (2,3-DMP), 2,6-dimethylpyrazine (2,6-DMP), 2-ethyl-5(6)-dimethylpyrazine (EMP), 2-ethylpyrazine (EP), 2-methylpyrazine (MP), and 2,3,5-trimethylpyrazine (TMP). The strain utilized 2,5-DMP as sole source of carbon and nitrogen and grew optimally at 25°C with a doubling time of 7.6 h. The degradation of 2,5-DMP was accompanied by the growth of the strain and by the accumulation of a first intermediate, identified as 2-hydroxy-3,6-dimethylpyrazine (HDMP). The disappearance of HDMP was accompanied by the release of ammonium into the medium. No other metabolite was detected. The degradation of 2,5-DMP and HDMP by strain DP-45 required molecular oxygen. The expression of the first enzyme in the pathway was induced by 2,5-DMP and HDMP whereas the second enzyme was constitutively expressed. The activity of the first enzyme was inhibited by diphenyliodonium (DPI), a flavoprotein inhibitor, methimazole, a competitive inhibitor of flavin-containing monooxygenases, and by cytochrome P450 inhibitors, 1-aminobenzotriazole (ABT) and phenylhydrazine (PHZ). The activity of the second enzyme was inhibited by DPI, ABT, and PHZ. Sodium tungstate, a specific antagonist of molybdate, had no influence on growth and consumption of 2,5-DMP by strain DP-45. These results led us to propose that a flavin-dependent monooxygenase or a cytochrome P450-dependent monooxygenase rather than a molybdenum hydroxylase catalyzed the initial hydroxylation step and that a cytochrome P450 enzyme is responsible for the transformation of HDMP in the second step.

Keywords: Biodegradation - odor - pyrazine - *Rhodococcus erythropolis*

Hung-Soo Joo¹, Makoto Shoda² and Chae-Gun Phae¹. (¹Department of Environmental Engineering, Seoul National University of Technology, 172 Kongneung-Dong, Nowon-Gu, Seoul, Korea, ²Chemical Resources Laboratory, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama, Japan. Chae-Gun Phae, Email: phae@snut.ac.kr). **Degradation of diesel oil in soil using a food waste composting process. *Biodegradation*, Volume 18(5) (2007): 597-605.**

We investigated the simultaneous degradation of diesel oil in soil and the organic matter in food waste by composting in 8 l reactors. Using a 0.5 l/min air flow rate, and 0.5-1% diesel oil concentrations together with 20% food waste, high composting temperatures (above 60°C) were attained due to the efficient degradation of the food waste. Petroleum hydrocarbons were degraded by 80% after only 15 days composting in the presence of food waste. In a 28 l reactor scale-up experiment using 1% oil, 20% food waste and 79% soil, removal efficiencies of petroleum hydrocarbons and food waste after 15 days were 79% and 77%, respectively.

Keywords: Composting - Diesel oil-contaminated soil - Food waste - Petroleum hydrocarbons

Leticia Pizzul¹, Åsa Sjögren¹, María del Pilar Castillo¹ and John Stenström¹. (¹Department of Microbiology, Swedish University of Agricultural Sciences, Box 7025, SE-750 07 Uppsala, Sweden. Leticia Pizzul, Email: Leticia.Pizzul@mikrob.slu.se). **Degradation of polycyclic aromatic hydrocarbons in soil by a two-step sequential treatment. Biodegradation, Volume 18(5) (2007): 604-616.**

The objectives of this work were to isolate the microorganisms responsible for a previously observed degradation of polycyclic aromatic hydrocarbons (PAH) in soil and to test a method for cleaning a PAH-contaminated soil. An efficient PAH degrader was isolated from an agricultural soil and designated as *Mycobacterium* LP1. In liquid culture, it degraded phenanthrene (58%), pyrene (24%), anthracene (21%) and benzo(a)pyrene (10%) present in mixture (initial concentration 50 µg ml⁻¹ each) and phenanthrene (92%) and pyrene (94%) as sole carbon sources after 14 days of incubation at 30°C. In soil, *Mycobacterium* LP1 mineralised ¹⁴C-phenanthrene (45%) and ¹⁴C-pyrene (65%) after 10 days. The good ability of this *Mycobacterium* was combined with the benzo(a)pyrene oxidation effect obtained by 1% w/w rapeseed oil in a sequential treatment of a PAH-spiked soil (total PAH concentration 200 mg kg⁻¹). The first step was incubation with the bacterium for 12 days and the second step was the addition of the rapeseed oil after this time and a further incubation of 22 days. Phenanthrene (99%), pyrene (95%) and anthracene (99%) were mainly degraded in the first 12 days and a total of 85% of benzo(a)pyrene was transformed during the whole process. The feasibility of the method is discussed.

Keywords: *Mycobacterium* - Polycyclic aromatic hydrocarbons - Rapeseed oil - Soil bioremediation

Jiandong Jiang¹, Ruifu Zhang^{1, 2}, Rong Li¹, Ji-Dong Gu² and Shunpeng Li¹. (¹Department of Microbiology, MOA Key Lab of Microbiological Engineering of Agricultural Environment, Nanjing Agricultural University, Nanjing, 210095, P.R. China, ²Department of Ecology and Biodiversity, Laboratory of Environmental Microbiology and Toxicology, The University of Hong Kong, Kadoorie Biological Sciences Building, Pokfulam Road, Hong Kong, SAR, P.R. China. Shunpeng Li, Email: lsp@njau.edu.cn). **Simultaneous biodegradation of methyl parathion and carbofuran by a genetically engineered microorganism constructed by mini-Tn5 transposon. Biodegradation, Volume 18(4) (2007): 403-412.**

A genetically engineered microorganism (GEM) capable of simultaneous degrading methyl parathion (MP) and carbofuran was successfully constructed by random insertion of a methyl parathion hydrolase gene (*mpd*) into the chromosome of a carbofuran degrading *Sphingomonas* sp. CDS-1 with the mini-transposon system. The GEM constructed was relatively stable and cell viability and original degrading characteristic was not affected compared with the original recipient CDS-1. The effects of temperature, initial pH value, inoculum size and alternative carbon source on the biodegradation of MP and carbofuran were investigated. GEM cells could degrade MP and carbofuran efficiently in a relatively broad range of temperatures from 20 to 30°C, initial pH values from 6.0 to 9.0, and with all initial inoculation cell densities (10⁵–10⁷ CFU ml⁻¹), even if alternative glucose existed. The optimal temperature and initial pH value for GEM cells to simultaneously degrade MP and carbofuran was at 30°C and at pH 7.0. The

removal of MP and carbofuran by GEM cells in sterile and non-sterile soil were also studied. In both soil samples, 50 mg kg⁻¹ MP and 25 mg kg⁻¹ carbofuran could be degraded to an undetectable level within 25 days even if there were indigenous microbial competition and carbon sources effect. In sterile soil, the biodegradation rates of MP and carbofuran were faster, and the decline of the inoculated GEM cells was slower compared with that in non-sterile soil. The GEM constructed in this study was potential useful for pesticides bioremediation in natural environment.

Keywords: Biodegradation - Carbofuran - Genetically engineered microorganism - Methyl parathion - Mini-transposon

Erkan Sahinkaya¹ and Filiz B. Dilek¹. (¹Environmental Engineering Department, Middle East Technical University, 06531 Ankara, Turkey. Filiz B. Dilek, Email: fdilek@metu.edu.tr). Modeling chlorophenols degradation in sequencing batch reactors with instantaneous feed-effect of 2,4-DCP presence on 4-CP degradation kinetics. Biodegradation, Volume 18(4) (2007): 427-437.

Two instantaneously fed sequencing batch reactors (SBRs), one receiving 4-chlorophenol (4-CP) (SBR4) only and one receiving mixture of 4-CP and 2,4-dichlorophenol (2,4-DCP) (SBRM), were operated with increasing chlorophenols concentrations in the feed. Complete degradation of chlorophenols and high-Chemical oxygen demand (COD) removal efficiencies were observed throughout the reactors operation. Only a fraction of biomass (competent biomass) was thought to be responsible for the degradation of chlorophenols due to required unique metabolic pathways. Haldane model developed based on competent biomass concentration fitted reasonably well to the experimental data at different feed chlorophenols concentrations. The presence of 2,4-DCP competitively inhibited 4-CP degradation and its degradation began only after complete removal of 2,4-DCP. Based on the experimental results, the 4-CP degrader's fraction in SBRM was estimated to be higher than that in SBR4 since 2,4-DCP degraders were also capable of degrading 4-CP due to similarity in the degradation pathways of both compounds.

Keywords: 4-chlorophenol - 2,4-dichlorophenol - Biodegradation kinetics - Competent biomass - Modeling - Sequencing batch reactor

Qiang He¹, Kai Yao², Danhong Sun¹ and Bi Shi¹. (¹The Key Laboratory of Leather Chemistry and Engineering of Ministry of Education, Sichuan University, Chengdu, 610065, P. R. China, ²The Department of Food Science and Engineering, Sichuan University, Chengdu, 610065, P. R. China. Bi Shi, Email: Sibitannin@vip.163.com). Biodegradability of tannin-containing wastewater from leather industry, Biodegradation, Volume 18(4) (2007): 465-472.

Tannins occur commonly in the wastewaters from forestry, plant medicine, paper and leather industries. The treatment of this kind of wastewaters, including settling and biodegradation, is usually difficult because tannins are highly soluble in water and would inhibit the growth of microorganisms in activated sludge. The objective of this study is to investigate biodegradability of tannin-containing wastewaters, so as to characterize the pollution properties of such wastewaters and provide a reference for their biological treatment in wastewater treatment plants. The research was typified by using the wastewater collected from vegetable tanning process in leather industry. A model was developed to describe the activated sludge process, and

the biodegradation kinetics of vegetable tanning wastewater (VET wastewater) was studied. It was found that the biodegradability of tannin-containing wastewater varies heavily with the content of tannins in wastewater. The biodegradation of VET wastewater with tannin content around 4,900 mg/l occurred inefficiently due to the inhibition of tannins to the activated sludge process, and only 34.7% of biodegradation extent was reached in 14 days of incubation. The optimal biodegradability of VET wastewater was observed when its tannin content was diluted to 490 mg/l, where the COD and tannin removals reached 51.3% and 45.1% respectively in 6 days. Hence, it is suggested that a proper control of tannin content is necessary to achieve an effective biodegradation of tannin-containing wastewaters in wastewater treatment plants.

Keywords: Tannins - Wastewater - Biodegradation - Leather industry

Kathryn M. Docherty¹, JaNeille K. Dixon² and Charles F. Kulpa Jr.¹. (¹Department of Biological Sciences, University of Notre Dame, PO Box 369, Notre Dame, IN 46556, USA, ²Department of Chemical Engineering, University of Notre Dame, Notre Dame, IN 46556, USA. Kathryn M. Docherty, Email: docherty.3@nd.edu). **Biodegradability of imidazolium and pyridinium ionic liquids by an activated sludge microbial community. Biodegradation, Volume 18(4) (2007): 481-493.**

Ionic liquids (ILs) are novel organic salts that have enormous potential for industrial use as green replacements for harmful volatile organic solvents. Varying the cationic components can alter the chemical and physical properties of ILs, including solubility, to suit a variety of industrial processes. However, to complement designer engineering, it is crucial to proactively characterize the biological impacts of new chemicals, in order to fully define them as environmentally friendly. Before introduction of ILs into the environment, we performed an analysis of the biodegradability of six ILs by activated sludge microorganisms collected from the South Bend, Indiana wastewater treatment plant. We examined biodegradability of 1-butyl, 1-hexyl and 1-octyl derivatives of 3-methyl-imidazolium and 3-methyl-pyridinium bromide compounds using the standard Organisation for Economic Cooperation and Development dissolved organic carbon Die-Away Test, changes in total dissolved nitrogen concentrations, and ¹H-nuclear magnetic resonance analysis of initial and final chemical structures. Further, we examined microbial community profiles throughout the incubation period using denaturing gradient gel electrophoresis (DNA-PCR-DGGE). Our results suggest that hexyl and octyl substituted pyridinium-based ILs can be fully mineralized, but that imidazolium-based ILs are only partially mineralized. Butyl substituted ILs with either cation, were not biodegradable. Biodegradation rates also increase with longer alkyl chain length, which may be related to enhanced selection of a microbial community. Finally, DGGE analysis suggests that certain microorganisms are enriched by ILs used as a carbon source. Based on these results, we suggest that further IL design and synthesis include pyridinium cations and longer alkyl substitutions for rapid biodegradability.

Keywords: Ionic liquids - Imidazolium - Pyridinium - Microbial biodegradability - Green chemistry

Aamer Ali Shah^a, Fariha Hasan^a, Abdul Hameed^a and Safia Ahmed^a. (^aMicrobiology Research Laboratory, Department of Microbiology, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad, Pakistan. [✉]*Scientific relevance of the paper: Biodegradability of the biodegradable plastics has been checked in our research work. We*

have isolated a bacterial strain *Bacillus* sp. AF3, capable of producing PHBV depolymerase enzyme, which assists in the degradation of PHBV. *Bacillus* sp. are the mostly reported as producers of biodegradable polyesters. We have indigenously isolated *Bacillus* sp. AF3 from sewage sludge which produced PHBV depolymerase responsible for the degradation of PHBV and also studied various parameters that can affect the activity of this enzyme. Corresponding author. Tel.: +92 51 2876245; fax: +92 51 9219888). Isolation and characterization of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) degrading bacteria and purification of PHBV depolymerase from newly isolated *Bacillus* sp. AF3^{AK}. *International Biodeterioration & Biodegradation*, Volume 60(2) (2007): 109-115

The contribution of bacteria, isolated from sewage sludge, towards the microbial degradation of poly (3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) was studied. A microbial consortium was inoculated on mineral salt agar plates containing different concentrations of PHBV as a substrate. The PHBV degraders showed optimum depolymerase production at pH 7.0, 37 °C, and 0.4% substrate concentration during 2–5 weeks of incubation. Additional carbon sources like glucose, fructose, sucrose, lactose and nitrogen sources including yeast extract were used as co-metabolites. The highest degree of degradation of PHBV was observed in the presence of glucose. Among the surfactants, Tween 80, was found to be a good inducer for the release of extracellular depolymerase enzyme as compared to Tween 20. When the PHBV depolymerase activity of isolates present in the consortium was determined separately, it was found that the enzyme activity was higher in case of *Bacillus* sp. AF3. The purification steps included ammonium sulfate fractionation and gel permeation chromatography on Sephadex G-75. The enzyme has been purified to homogeneity as judged by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and molecular weight was found to be approximately 37 kDa.

Keywords: Biodegradation; PHBV depolymerase; Poly (3-hydroxybutyrate-co-3-hydroxyvalerate)

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A bacterial isolate that degraded acrylamide (AM) as sole carbon and nitrogen source was isolated from AM-contaminated soil samples and identified as *Pseudomonas aeruginosa*. When tested for the efficiency of degrading AM by monitoring acidity and ammonia release, the bacterium degraded 1–2% AM effectively with release of 7 mg ammonia l⁻¹. Mercury and chromium inhibited AM degradation, while nickel enhanced the process at lower concentrations, e.g., 200 and 400 ppm. Free *Ps. aeruginosa* cells began the degradative activity only after incubation for 24 h, while immobilized cells started before 24 h. HPLC analysis of the degradation products revealed intermediate compounds indicative of degradation of AM.

Keywords: Acrylamide; Biodegradation; *Pseudomonas aeruginosa*; Immobilization

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Sediment Sciences, Ministry of Education, Department of Environmental Engineering, Peking University, Beijing 100871, China, ^cDepartamento de Microbiología, Escuela Nacional de Ciencias Biológicas, IPN, México, D.F. 11340, México. [✉]This is a original research paper concerning about the wood chip degradation directly by *Pseudomonas* sp., which was not mentioned before. Corresponding author. Tel.: +86 10 62733464; fax: +86 10 62731332). Biodegradation of three different wood chips by *Pseudomonas* sp. PKE117 [✉] International Biodeterioration & Biodegradation, Volume 60(2) (2007): 90-95

Biodegradation of wood chips of broad-leaved trees *Eucalyptus grandis*×*Eucalyptus urophylla* and *Populus canadensis*, and of the conifer *Larix olgensis* by *Pseudomonas* sp. PKE117 was studied. After 60 days of biopulping by PKE117, the weight losses of *E. grandis*×*E. urophylla*, *P. canadensis* and *L. olgensis* were 7.58%, 17.15% and 26.75%, respectively. Elemental analysis showed that the C, H contents of three wood chips decreased and O content increased after the biopulping. FT-IR results also showed that the lignin structure was destroyed more than that of cellulose. Solid-state CP/MAS 13C-NMR spectroscopy results showed that the content of guaiacylpropanoid (G) lignin-unit in lignin of three samples decreased after biodegradation. The hemicellulose in *L. Olgensis* decreased much more than other samples. All the results demonstrated that the degradation of *L. olgensis* by *Pseudomonas* sp. PKE117 was more efficient than that of *P. canadensis* and *E. grandis*×*E. urophylla*. The strain *Pseudomonas* sp. PKE117 could be an alternative bioagent to replace the white-rot fungi in the biopulping of softwood.

Keywords: *Pseudomonas* sp.; Biodegradation; Biopulping; Wood chip; Lignin

Przemysław Bernat^a and Jerzy Długoński^a. (^aDepartment of Industrial Microbiology and Biotechnology, University of Lodz, Banacha 12/16, PL 90-237 Łódź, Poland. [✉]*The scientific relevance of the paper:* Our results show that the resistance of *C. elegans* to tributyltin chloride (TBT), a membrane active substance, is associated with the ability of the fungus to modulate fatty acids composition in response to the xenobiotic and to metabolise the biocide to less toxic derivatives: dibutyltin (DBT) and monobutyltin (MBT). Corresponding author. Tel.: +48 42 6354465; fax: +48 42 6655818). Tributyltin chloride interactions with fatty acids composition and degradation ability of the filamentous fungus *Cunninghamella elegans* [✉] International Biodeterioration & Biodegradation, Volume 60(3) (2007): 133-136

Toxic organotin compounds are widely present in the environment. Tributyltin chloride (TBT), an organotin, is degraded by a filamentous fungus *Cunninghamella elegans*. The major fatty acids of this fungus were: palmitate (16:0), stearate (18:0), oleate (18:1n9), linoleate (18:2n6) and γ -linolenate (18:3n6). We show that the fatty acid unsaturation index was decreased and the conversion of stearic acid (18:0) in oleic acid (18:1n9) was significantly inhibited in the presence of TBT. Changes in fatty acid compositions during TBT degradation at 10 mg l⁻¹ in *C. elegans* revealed that the degree of saturation was correlated with biotransformation of the xenobiotic to less toxic compounds: dibutyltin and monobutyltin. Our results suggest that the high TBT resistance in *C. elegans* is associated with the modulation of the fatty acids composition and the biocide degradation.

Keywords: *Cunninghamella elegans*; Fatty acids composition; TBT degradation

C. Abrusci^a, D. Marquina^a, A. Del Amo^b and F. Catalina^c. (^aDepartamento de Microbiología III, Facultad de Biología, Universidad Complutense de Madrid, José Antonio Novais, 2, 28040 Madrid, Spain, ^bFilmoteca Española, Magdalena 10, 28012 Madrid, Spain, ^cDepartamento de Fotoquímica de Polímeros, Instituto de Ciencia y Tecnología de Polímeros, C.S.I.C., Juan de la Cierva 3, 28006 Madrid, Spain. Corresponding author. Tel.: +34 91 5622900; fax: +34 91 564 48 53). Biodegradation of cinematographic gelatin emulsion by bacteria and filamentous fungi using indirect impedance technique. *International Biodeterioration & Biodegradation*, Volume 60(3) (2007), Pages 137-143

The biodegradation of black and white photographic gelatin emulsion by bacteria and fungi was studied by indirect impedance technology. The presence of silver on the emulsion (black films) inhibited the microbial growth confirming the biocidal effect of the metallic silver. Biodegradation of commercial gelatines, linear and crosslinked (prepared using formaldehyde as crosslinking agent) by *Bacillus subtilis* was studied. The extent of crosslinking in the gelatin does not have any influence on the biodegradation rate. Through the accumulated amount of CO₂ produced with bioassay time and the corresponding percentage of biodegradation reached, the relative biodegradation efficiency of the bacteria and fungi was evaluated. The six studied bacteria (five strains of *Bacillus* and one *Staphylococcus*) were effective in their ability to biodegrade the photographic emulsion with different CO₂ production rates. Two of them, *B. subtilis* and *B. megaterium* showed an exponential rate of biodegradation and reaching 55% of CO₂ conversion. Also, all the studied fungi, nine strains, were found to biodegrade the emulsion with *Penicillium chrysogenum* being the more efficient fungus showing 30% of emulsion biodegradation in 3 weeks.

Keywords: Photographic emulsion; Biodegradation by bacteria and fungi; Film biodeterioration; Indirect impedance

M. Sudhakar^a, C. Priyadarshini^a, Mukesh Doble^a, P. Sriyutha Murthy^b and R. Venkatesan^b. (^aDepartment of Biotechnology, Indian Institute of Technology Madras, Chennai 36, India, ^bOSTI, National Institute of Ocean Technology, Chennai 302, India. Corresponding author. Tel.: +91 44 22574107). Marine bacteria mediated degradation of nylon 66 and 6. *International Biodeterioration & Biodegradation*, Volume 60(3) (2007): 144-151

Marine bacteria (*Bacillus cereus*, *Bacillus sphericus*, *Vibrio furnisii*, and *Brevundimonas vesicularis*) were shown to degrade nylon 6 and 66 in mineral salt medium at 35 °C and pH of 7.5 under submerged enrichment conditions with the polymer as the sole carbon source. The degradation led to the formation of new functional groups NHCHO, CH₃, CONH₂, CHO and COOH. Maximum degradation was observed with *Bacillus cereus* for both the nylons. Average molecular weight decreased by 42% and 31% and weight decreased by 7% and 2% in the case of nylon 66 and nylon 6, respectively, over a period of three months. Differential scanning calorimetry showed a reduction in melting temperature (T_m of 1 °C) and enthalpies of fusion indicating decrease in crystallinity. Epi-fluorescent microscope of the degraded samples showed surface stripping and groves. The extent of degradation observed with the marine organisms was better than soil organisms reported in the literature.

Keywords: Nylon 6, 66; Biodegradation; Marine bacteria

Xiaoyu Zhang^a, Hongbo Yu^a, Huiyan Huang^a and Youxun Liu^a. (^aCollege of Life Science and Technology, Huazhong University of Science and Technology, 430074 Wuhan, P.R. China. Corresponding author. Tel.: +86 27 8779 2128; fax: +86 27 8779 2108). Evaluation of biological pretreatment with white rot fungi for the enzymatic hydrolysis of bamboo culms. *International Biodeterioration & Biodegradation*, Volume 60(3) (2007): 159-164

Biological pretreatment with white rot fungi has shown potential for improving enzymatic hydrolysis of wood and grass. In this study, 34 isolates of white rot fungi were screened for the biological pretreatment of bamboo culms (*Phyllostachys pubescence*). *Echinodontium taxodii* 2538 and *Trametes versicolor* G20 were selected for further evaluation of pretreatment because they caused high lignin loss (>20%) and high selectivity value of lignin degradation (>2) after the 4-week biodegradation. Fermentable sugar yield of bamboo culms pretreated with these two fungi through enzymatic hydrolysis increased with increasing pretreatment time. Sugar yield of bamboo culms pretreated with *T. versicolor* G20 and *E. taxodii* 2538 increased 5.15-fold and 8.76-fold, respectively, after 120-day pretreatment. FTIR analysis showed that *E. taxodii* 2538 preferentially degraded the lignin of bamboo culms. The pretreated bamboo culms showed significant increase of initial adsorption capacity to cellulase (4.20-fold and 6.66-fold for *T. versicolor* G20 and *E. taxodii* 2538, respectively, after 120 days) and decrease of lignin content (12.00% and 29.14% for *T. versicolor* G20 and *E. taxodii* 2538, respectively, after 120 days) with increasing pretreatment time. Initial adsorption capacity and lignin content of bamboo culms were correlated to fermentable sugar yield.

Scientific relevance

This paper focused on the biodegradation and pretreatment of bamboo culms with white rot fungi. Bamboo culms pretreatment with white rot fungi was evaluated firstly for energy convention of lignocellulose. This paper studied effects of lignin content and initial adsorption capacity on enzymatic hydrolysis also.

Keywords: *Trametes versicolor*; *Echinodontium taxodii*; Bamboo culms; Biological pretreatment; Enzymatic hydrolysis; Lignin; Adsorption

Vanessa Leonardi^a, Václav Šásek^b, Maurizio Petruccioli^a, Alessandro D'Annibale^a, Pavla Erbanová^b and Tomáš Cajthaml^b. (^aDepartment of Agrochemistry and Agrobiology, University of Tuscia, Via San Camillo de Lellis, snc I-01100 Viterbo, Italy, ^bInstitute of Microbiology, Academy of Sciences of the Czech Republic, Videnska 1083, 142 20 Prague 4, Czech Republic. Corresponding author. Tel.: +42 022 41062498; fax: +42 022 41062384). Bioavailability modification and fungal biodegradation of PAHs in aged industrial soils. *International Biodeterioration & Biodegradation*, Volume 60(3) (2007): 165-170

Bioavailability of pollutants in contaminated soils represents an important factor influencing the bioremediation process. We investigated the impact of the bioavailability of polycyclic aromatic hydrocarbons (PAHs) on the efficacy of mycoremediation of aged matrices. Two historically contaminated soils, differing in both overall PAH concentrations (2320 vs. 612 mg PAHs kg⁻¹) and in the relative amount of the non-bioavailable fraction (4.0 vs. 32%, respectively), were incubated with two white rot fungi – *Irpex lacteus* and *Pleurotus ostreatus*. When relating biodegradation results with the amount of PAH bioavailable fractions estimated by sequential supercritical fluid extractions, the correlation coefficients ranged from 0.60 to 0.83. In order to

assess a possible increase of the mycoremediation efficiency, four different mobilizing agents (MAs), i.e. soybean oil, Tween 20, Tween 80 and olive-mill wastewater, were added to soil prior to fungal incubations. The addition of MAs to the soil with a negligible amount of the non-bioavailable fraction had either a limited or even a negative impact on PAH degradation. The same was true also in the case of the other soil, characterized by a larger non-bioavailable fraction. Both white rot fungi under study markedly degraded PAHs in historically contaminated soils differing significantly in PAH content and the bioavailability. However, both the fungi performed better in the soil with higher pollutant bioavailability. Consequently, a preliminary determination of non-bioavailable fraction might provide a useful indication of the performance of bioremediation treatment.

Keywords: Mobilizing agents; Mycoremediation; Sequential supercritical fluid extraction; Polycyclic aromatic hydrocarbons; White rot fungi

R.I. Dams^{a, 1}, G. Paton^b and K. Killham^b. (^aUnivali—Universidade do Vale do Itajaí, 5^a avenida s/n, Bairro dos Municípios, Balneário Camboriú, CEP: 88330-000, SC, Brazil, ^bPlant and Soil Department, University of Aberdeen, Aberdeen, Scotland, UK. Corresponding author. Tel.: +55 47 3261 1234. ¹This work has been done as part of a Ph.D. degree at the University of Aberdeen, UK with the support of the National Council for Scientific and Technological Development, CNPq). **Bioaugmentation of pentachlorophenol in soil and hydroponic systems. International Biodeterioration & Biodegradation, Volume 60, Issue 3, 2007, Pages 171-177**

Sphingobium chlorophenolicum is well known as pentachlorophenol (PCP) degrader. The objective of this study was to evaluate the PCP degradation in soil and hydroponic systems using a bioaugmentation technique. Measurements of PCP concentrations were carried out using high-performance liquid chromatography (HPLC) analyses. The toxic effect of PCP on plants was studied through the monitoring of plant weight. An acute toxicity assay of PCP was performed using *Escherichia coli* HB101 pUCD607. The introduction of *S. chlorophenolicum* into soil with plants showed a faster degradation when compared to the non-inoculated soil. In the soil system, plants acted as a vector to the target compound, PCP. The monitoring of the plant growth showed a protective role of *S. chlorophenolicum* against the toxicity of PCP. In the hydroponic system *S. chlorophenolicum* showed the ability to degrade 16 mg l⁻¹ after 7 days of experiments at both concentrations tested (20 and 30 mg l⁻¹ PCP). The bioassay confirmed that initial toxicity was lowered while degradation progressed in both systems.

Keywords: Pentachlorophenol degradation; *Sphingobium chlorophenolicum*; Hydroponic systems; Soil systems

Shogo Nakamura^a, Yoshihiko Sakamoto^a, Miho Ishiyama^a, Daisuke Tanaka^a, Katsuyuki Kunii^b, Kazushige Kubo^b and Chubun Sato^c. (^aDepartment of Environmental Biology and Chemistry, Faculty of Science, University of Toyama, 3190 Gofuku, Toyama 930-8555, Japan, ^bTakamatsu Technical Research Institute of Shikoku Instrumentation Co., Ltd., Takamatsu, Kagawa 761-0301, Japan, ^cFaculty of Education for Future Generation, International Pacific University, Okayama 709-0863, Japan. [✉]It is our hope that this paper will contribute to an understanding of cooperative relationship between indigenous bacteria including *Alcanivorax* sp. in the process of biodegradation of oil-polluted environments . Corresponding author. Tel.: +81 76 445 6673; fax: +81 76 445 6549).

Characterization of two oil-degrading bacterial groups in the Nakhodka oil spill[✉]
International Biodeterioration & Biodegradation, Volume 60(3) (2007): 202-207

In January 1997, a heavy oil spill from the Russian tanker Nakhodka occurred in the Japan Sea. We have isolated two bacterial groups, ODB-G1 and ODB-G2, from the spilled oil. Using physiological analysis, electron microscopy, and 16S rDNA sequence analysis, ODB-G1 were shown to contain two genera, *Caulobacter* sp. and *Alcanivorax* sp. ODB-G2 also contained two genera, *Halomonas* sp. and *Alcanivorax* sp. Their abilities to degrade oil components were examined by TLC/FID method or by the change in the dry weight of the heavy oil with which they were incubated. The results obtained by the TLC/FID method showed that ODB-G1 and ODB-G2 degraded the saturate fraction and the aromatic fraction very well. They were also able to degrade the resin and the asphaltene fraction, although the quantity was less. The *Alcanivorax* sp. degraded heavy oil well, but the *Caulobacter* sp. and the *Halomonas* sp. were found unable to degrade heavy oil as assessed by the change in the dry weight of heavy oil. Interestingly, ODB-G1 (a mixture of *Caulobacter* sp. and *Alcanivorax* sp.) and ODB-G2 (a mixture of *Halomonas* sp. and *Alcanivorax* sp.) displayed a higher degradation rate than *Alcanivorax* sp. alone.

Keywords: Biodegradation; Heavy oil; Nakhodka oil spill; *Alcanivorax* sp.

Gursharan Singh^a, Neena Capalash^b, Rashmi Goel^a and Prince Sharma^a. (^aDepartment of Microbiology, Panjab University, Chandigarh 160014, India, ^bDepartment of Biotechnology, Panjab University, Chandigarh 160014, India. Corresponding author. Tel.: +91 172 2534147; fax: +91 172 2545425). **A pH-stable laccase from alkali-tolerant γ -proteobacterium JB: Purification, characterization and indigo carmine degradation. Enzyme and Microbial Technology, Volume 41(6-7) (2007): 794-799**

γ -Proteobacterium JB, an alkali-tolerant soil isolate, produced laccase constitutively in unbuffered medium. The enzyme was purified to homogeneity by ammonium sulphate precipitation, DEAE-sepharose anion exchange chromatography and preparatory polyacrylamide gel electrophoresis. The purified enzyme was a monomeric polypeptide (MW 120 kDa) and absorbed at 590 nm indicating the presence of Type I Cu²⁺-centre. It worked optimally at 55 °C and showed different pH optima for different substrates. The enzyme was highly stable in the pH range 4–10 even after 60 days at 4 °C. K_m and V_{max} values for syringaldazine, catechol, pyrogallol, *p*-phenylenediamine, 1-methyl DOPA and guaiacol substrates were determined. Inhibitors, viz. azide, diethyldithiocarbamate, thioglycollate and cysteine-hydrochloride all inhibited laccase non-competitively using guaiacol as substrate at pH 6.5. The enzyme degraded indigo carmine (pH 9, 55 °C) to anthranilic acid via isatin as determined spectrophotometrically and by HPLC analysis. Degradation was enhanced in the presence of syringaldehyde (571%), vanillin (156%) and *p*-hydroxybenzoic acid (91.6%) but not HOBT.

Keywords: Laccase; pH-stable; γ -Proteobacterium; Indigo; Isatin; Degradation

Dimitrios G. Karpouzas^a, Anastasia Fotopoulou^a, Urania Menkissoglu-Spiroudi^a and Brajesh K. Singh^b. (^aFaculty of Agriculture, Laboratory of Pesticide Science, Aristotle University of Thessaloniki, P.O. Box 1678, Thessaloniki 54124, Greece, ^bDepartment of Environmental Sciences, The Macaulay Institute, Craigiebuckler, Aberdeen AB15 8QH, UK. Corresponding author. Tel./fax: +30 231 099 8835) **Non-specific biodegradation of the organophosphorus pesticides, cadusafos and ethoprophos, by two bacterial isolates. FEMS Microbiology Ecology, Volume 53(3) (2005): 369-378**

An enrichment culture technique was used for the isolation of microorganisms responsible for the enhanced biodegradation of the nematicide cadusafos in soils from a potato monoculture area in Northern Greece. Mineral salts medium supplemented with nitrogen (MSMN), where cadusafos (10 mg l⁻¹) was the sole carbon source, and soil extract medium (SEM) were used for the isolation of cadusafos-degrading bacteria. Two pure bacterial cultures, named CadI and CadII, were isolated and subsequently characterized by sequencing of 16S rRNA genes. Isolate CadI showed 97.4% similarity to the 16S rRNA gene of a *Flavobacterium* strain, unlike CadII which showed 99.7% similarity to the 16S rRNA gene of a *Sphingomonas paucimobilis*. Both isolates rapidly metabolized cadusafos in MSMN and SEM within 48 h with concurrent population growth. This is the first report for the isolation and characterization of soil bacteria with the ability to degrade rapidly cadusafos and use it as a carbon source. Degradation of cadusafos by both isolates was accelerated when MSMN was supplemented with glucose. In contrast, addition of succinate in MSMN marginally reduced the degradation of cadusafos. Both isolates were also able to degrade completely ethoprophos, a nematicide chemical analog of cadusafos, but did not degrade the other organophosphorus nematicides tested such as isazofos and isofenphos. Inoculation of a soil freshly treated with cadusafos or ethoprophos (10 mg l⁻¹) with high inoculum densities (4.3×10^8 cells g⁻¹) of *Sphingomonas paucimobilis* resulted in the rapid degradation of both nematicides. These results indicate the potential of this bacterium to be used in the clean-up of contaminated pesticide waste in the environment.

Keywords: Biodegradation; Organophosphorus pesticides; Cadusafos; *Shingomonas*; *Flavobacterium*

Zhi-Jian Yang¹, Wei Wang¹, Ying Jin¹, Hong-Bo Hu¹, Xue-Hong Zhang¹ and Yu-Quan Xu¹. (¹Key Laboratory of Microbial Metabolism, Ministry of Education, College of Life Science and Biotechnology, Shanghai Jiao Tong University, 800 Dongchuan Road, Shanghai, 200240, PRC. Hong-Bo Hu, Email: hbhu@sjtu.edu.cn). **Isolation, Identification, and Detgradation Characteristics of Phenazine – 1 – Carboxylic Acid – Degrading Strain *Sphingomonas* sp. DP58. Current Microbiology, Vol. 55(4)(2007): 284-287.**

A phenazine-1-carboxylic acid (PCA)-degrading bacterium, strain DP58, was isolated from pimiento rhizosoil. Based on morphology, physiologic tests, 16S rDNA sequence, and phylogenetic characteristics, it was identified as *Sphingomonas* sp. The PCA-degradation experiments were conducted both in Luria-Bertani and inorganic salt medium at 28°C. The relationship between bacterium growth and PCA degradation suggested that strain DP58 could use PCA as the sole source of carbon and nitrogen and was able to completely degrade PCA in 40 hours. Newly isolated strain DP58 represents the first bacterium that can degrade PCA.

Lorena I. Luppi^a, Ivo Hardmeier^b, Paola A. Babay^c, Raúl F. Itria^a and Leonardo Erijman^d. (^aCentro de Investigación y Desarrollo de Ingeniería Ambiental, (INTI – Ingeniería Ambiental), Buenos Aires, Argentina, ^bINTI-Química, Buenos Aires, Argentina, ^cUnidad de Actividad Química, Comisión Nacional de Energía Atómica (UAQ-CNEA), Buenos Aires, Argentina, ^dInstituto de Investigaciones en Ingeniería, Genética y Biología Molecular (INGEBI-CONICET), Obligado 2490, (ADN1428) Buenos Aires, Argentina). **Anaerobic nonylphenol ethoxylate degradation coupled to nitrate reduction in a modified biodegradability batch test. Chemosphere, Volume 68(11) (2007): 2136-2143**

The aim of this work was to elucidate the role of nitrate as a terminal electron acceptor on the biodegradation of NPEO. We have characterized the products of NPEO degradation by mixed microbial communities in anaerobic batch tests by means of HPLC, ¹H NMR and GC-MS. Anaerobic degradation of NPEO was strictly dependent on the presence of nitrate. Within seven days of anoxic incubation, NP2EO appeared as the major degradation product. After 21 days, NP was the main species detected, and was not degraded further even after 35 days. Nitrate concentration decreased in parallel with NPEO de-ethoxylation. A transient accumulation of nitrite was observed within the time period in which NP formation reached its maximum production. The observed generation of nonylphenol coupled to nitrate reduction suggests that the microbial consortium possessed an alternate pathway for the degradation of NPEO, which was not accessible under aerobic conditions.

Keywords: Nonylphenol polyethoxylates; Endocrine disruptor; Anoxic biodegradation

Pablo Campo^a, Yuechen Zhao^a, Makram T. Suidan^a, Albert D. Venosa^b and George A. Sorial^a. (^aDepartment of Civil and Environmental Engineering, University of Cincinnati, Cincinnati, OH 45221-0071, United States, ^bUS EPA National Risk Management Research Laboratory, Cincinnati, OH 45268, United States. Corresponding author. Tel.: +1 513 556 3695; fax: +1 513 556 2599). **Biodegradation kinetics and toxicity of vegetable oil triacylglycerols under aerobic conditions. Chemosphere, Volume 68(11) (2007): 2054-2062**

The aerobic biodegradation of five triacylglycerols (TAGs), three liquids [triolein (OOO), trilinolein (LLL), and trilinolenin (LnLnLn)] and two solids [tripalmitin (PPP) and tristearin (SSS)] was studied in water. Respirometry tests were designed and conducted to determine the biochemical oxygen demand (BOD) parameters of the compounds. In the case of the solid lipids, the degradation process was limited by their extremely non-polar nature. When added to water, PPP and SSS formed irregular clumps or gumballs, not a fine and uniform suspension required for the lipase activity. After 30 days, appreciable mineralization was not achieved; therefore, first-order biodegradation coefficients could not be determined. The bioavailability of the liquid TAGs was restricted due to the presence of double bonds in the fatty acids (FAs). An autoxidation process occurred in the allylic chains, resulting in the production of hydroperoxides. These compounds polymerized and became non-biodegradable. Nevertheless, the non-oxidized fractions were readily mineralized, and BOD rate constants were estimated by non-linear regression: LLL ($k = 0.0061 \text{ h}^{-1}$) and LnLnLn ($k = 0.0071 \text{ h}^{-1}$) were degraded more rapidly than OOO ($k = 0.0025 \text{ h}^{-1}$). Lipids strongly partitioned to the biomass and, therefore, Microtox[®] toxicity was not observed in the water column. However, EC₅₀ values (<15% sample volume) were measured in the solid phase.

Keywords: Triacylglycerols; Fatty acids; Respirometry; Toxicity; Autoxidation

Atsushi Shibata^a, Koki Toyota^b, Katsuhide Miyake^c and Arata Katayama^{a, c}. (^aDepartment of Geotechnical and Environmental Engineering, Nagoya University, Chikusa, Nagoya 464-8603, Japan, ^bGraduate School of Bio-Applications and Systems Engineering, Tokyo University of Agriculture and Technology, Tokyo, Japan, ^cEcoTopia Science Institute, Nagoya University, Chikusa, Nagoya 464-8603, Japan. Corresponding author. Address: EcoTopia Science Institute, Nagoya University, Furo-cho, Chikusa, Nagoya 464-8603, Japan. Tel.: +81 52 789 5856; fax: +81 52 789 5857). **Anaerobic biodegradation of 4-alkylphenols in a paddy soil microcosm supplemented with nitrate. Chemosphere, Volume 68(11) (2007): 2096-2103**

Anaerobic degradation of phenol, *p*-cresol, 4-*n*-propylphenol (*n*-PP), 4-*i*-propylphenol (*i*-PP), 4-*n*-butylphenol (*n*-BP) and 4-*sec*-butylphenol (*sec*-BP) was observed in a paddy soil supplemented with nitrate. We detected the metabolites 4'-hydroxypropiofenone (HPP) from *n*-PP, 4-*i*-propenylphenol from *i*-PP, and 4-(1-butenyl)phenol and 4'-hydroxybutyrophenone (HBP) from *n*-BP. Compared with the original soils, *Betaproteobacteria* became predominant in the microcosm during the degradation of phenol and *p*-cresol whereas no remarkable change was observed in the community degrading propylphenols and butylphenols. The microcosm, however, did not degrade 4-*t*-butylphenol (*t*-BP), 4-*t*-octylphenol (*t*-OP) and 4-*n*-octylphenol (*n*-OP). Paddy soil supplemented with sulfate or iron (III) as electron acceptors did not degrade phenol and 4-alkylphenols with the exception of the degradation of *p*-cresol in sulfate-reducing conditions. It was demonstrated for the first time that anaerobic microbial degradation of alkylphenols, in a paddy soil supplemented with nitrate as an electron acceptor, occurred via oxidation of the alpha carbon in the alkyl chain.

Keywords: Propylphenols; Butylphenols; Nitrate reduction; PCR-DGGE; Quinone profile

Xiang-Yang Gu^a and Jonathan W.C. Wong^{a, b}. (^aDepartment of Microbiology, Nanjing Agricultural University, Nanjing 210095, People's Republic of China, ^bDepartment of Biology, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, People's Republic of China. Corresponding author. Address: Department of Biology, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, People's Republic of China. Tel.: +852 3411 7056; fax: +852 3411 5995). **Degradation of inhibitory substances by heterotrophic microorganisms during bioleaching of heavy metals from anaerobically digested sewage sludge. Chemosphere, Volume 69, Issue 2, September 2007, Pages 311-318**

The presence of organic acids was found to be inhibitory to the bioleaching of sewage sludge and the objective of the present study was to elucidate the roles of heterotrophic microorganisms in removing organic acids during the bioleaching of heavy metals from anaerobically digested sewage sludge. Microbiological analysis showed that acetic and propionic acids posed a severe inhibitory effect on iron-oxidizing bacteria as reflected by a sharp decrease in their viable counts in the first 4 d and it only started to increase 2 d after the depletion of both acids. Biodegradation of these inhibitory organic acids was revealed by sharp increases in total fungi and acidophiles between day 3 and day 5 which coincided with degradation of organic acids. This was further confirmed by the increases in total counts of both acetate and propionate degraders in the same period. Two yeast strains Y4 and Y5 with strong ability to degrade acetate and/or propionate were isolated and identified as *Pichia* sp. and *Blastoschizomyces capitatus*, respectively. *B. capitatus* Y5 was an more important player in removing the inhibitory organic acids during the bioleaching process since it could utilize both acetate and propionate as sole carbon source while *Pichia* sp. Y4 was an strict acetate degrader. Results from the present study not only provided

the evidence for biodegradation of organic acids by heterotrophs, but also disclosed a biological mechanism for the initiation of bioleaching of organic acid-laden sewage sludge.

Keywords: Bioleaching; Heavy metal; Sewage sludge; *Acidithiobacillus ferrooxidans*; Organic acid

David Warshawsky^a, Kathy LaDow^a and Joanne Schneider^a. (^aDepartment of Environmental Health, University of Cincinnati Medical Center, P.O. Box 670056, 3223 Eden Avenue, Cincinnati, OH 45267-0056, USA. Corresponding author. Tel.: +1 513 558 0152; fax: +1 513 558 5561.). **Enhanced degradation of benzo[a]pyrene by *Mycobacterium* sp. in conjunction with green alga. *Chemosphere*, Volume 69(3) (2007): 500-506**

Previous work in this laboratory has confirmed that the bacteria *Mycobacterium* sp. strain RJGII.135 and *Sphingomonas yanoikuyae* strain B1 and the green alga *Selenastrum capricornutum* strain UTEX 1648 degrade benzo[a]pyrene (BaP) to various BaP intermediates. *S. capricornutum* was first grown with BaP for 4 days. The organic extract of this media was then introduced into separate cultures of strain RJGII.135 and strain B1; separate cultures were grown with BaP for comparison. Cultures grown with BaP and those grown with the algal/BaP extract showed similar mineralization patterns. The quantity of total metabolites formed was greater in bacterial cultures grown with the algal/BaP extract than those grown with BaP alone. For strain RJGII.135, only 27% of the original BaP remained in cultures grown with the algal/BaP extract; 59% remained in cultures grown with BaP. For strain B1, only 6% of the original BaP remained in cultures grown with the algal/BaP extract; 38% remained in cultures grown with BaP. These results indicate that strategies utilizing organisms together may be necessary in being able to degrade large, recalcitrant polycyclic aromatic hydrocarbons (PAHs) such as BaP.

Keywords: Biodegradation; Benzo[a]pyrene; *Selenastrum capricornutum*; *Mycobacterium* sp.; *Sphingomonas yanoikuyae*

Shu-Guang Wang^a, Xian-Wei Liu^a, Hua-Yong Zhang^b, Wen-Xin Gong^a, Xue-Fei Sun^a and Bao-Yu Gao^a. (^aSchool of Environmental Science and Engineering, Shandong University, Jinan 250100, China, ^bEnergy and Environmental Research Center, North China Electric Power University, Beijing 102206, China. Corresponding author. Tel.: +86 531 88362802; fax: +86 531 88364513). **Aerobic granulation for 2,4-dichlorophenol biodegradation in a sequencing batch reactor. *Chemosphere*, Volume 69(5) (2007): 769-775**

Development of aerobic granules for the biological degradation of 2,4-dichlorophenol (2,4-DCP) in a sequencing batch reactor was reported. A key strategy was involving the addition of glucose as a co-substrate and step increase in influent 2,4-DCP concentration. After operation of 39 d, stable granules with a diameter range of 1–2 mm and a clearly defined shape and appearance were obtained. After granulation, the effluent 2,4-DCP and chemical oxygen demand concentrations were 4.8 mg l⁻¹ and 41 mg l⁻¹, with high removal efficiencies of 94% and 95%, respectively. Specific 2,4-DCP biodegradation rates in the granules followed the Haldane model for substrate inhibition, and peaked at 39.6 mg 2,4-DCP g⁻¹ VSS⁻¹ h⁻¹ at a 2,4-DCP concentration of 105 mg l⁻¹. Efficient degradation of 2,4-DCP by the aerobic granules suggests their potential application in the treatment of industrial wastewater containing chlorophenols and other inhibitory chemicals.

Keywords: 2,4-dichlorophenol (2,4-DCP); Aerobic granule; Biodegradation; Cometabolism; Haldane kinetics; Sequencing batch reactor (SBR)

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The present study deals with the biodegradation of catechol through co-metabolism with glucose in aqueous solution as primary substrate in an upflow anaerobic sludge blanket (UASB) reactor. Batch studies indicated that the 1000 mg l⁻¹ glucose concentration was sufficient to cometabolize and degrade catechol in an aqueous solution up to a concentration of 1000 mg l⁻¹. The reactor operated at 35 ± 2 °C, and at a constant hydraulic retention time of 8 h with a gradual stepwise increase in catechol concentration from 100 to 1000 mg l⁻¹ along with glucose as a cosubstrate. The results showed that the catechol was successfully mineralized in an UASB reactor in which microbial granulation was achieved with only glucose as the substrate. The reactor showed ≥95% COD removal efficiency with 500–1000 mg l⁻¹ catechol concentration in the feed and a glucose concentration of 1500 mg l⁻¹ as a cosubstrate. Similar efficiency was obtained at a constant catechol concentration of 1000 mg l⁻¹ with 500–1000 mg l⁻¹ glucose concentration. Once the reactor got acclimatized with catechol, higher concentrations of catechol can be mineralized with a minimum amount of glucose as the cosubstrate without affecting the performance of the UASB reactor.

Keywords: UASB reactor; Catechol; Glucose; Cosubstrate; Temperature shock

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In the present study, a refined microbially-influenced degradation method was used to evaluate the stability of a solidified synthetic waste containing chromium salt, cement and fly ash in two different proportions. The experimental samples showed evidence of microbial growth by leaching of sulfate. Chromium leached by *Thiobacillus thiooxidans* from the experimental samples 'C1' (10.26% CrCl₃ · 6H₂O; 89.74% cement) and 'FC1' (10.26% CrCl₃ · 6H₂O; 10% fly ash; 79.74% cement), after 30 days of exposure was 14.53 mg/g and 9.53 mg/g, respectively. The corresponding concentration of chromium in the leachate was 0.189 mg/l and 0.124 mg/l, respectively, which was lower than the toxicity characteristic leaching procedure (TCLP), regulatory limit (5 mg/l). Replacement of cement by 10% fly ash in FC1 restricted the leaching of chromium more effectively. Model equations based on two shrinking core models namely, acid dissolution and bulk diffusion model, were used to analyze the kinetics of microbial degradation. Of the two approaches, the bulk diffusion model fit the data better than the acid dissolution model as indicated by the correlation coefficients of >0.97.

Keywords: Solidified waste; Microbially-influenced degradation; *Thiobacillus thiooxidans*; Shrinking core models

Yan Jiang^{a, b}, Jianping Wen^a, Jing Bai^a, Xiaoqiang Jia^a and Zongding Hu^a. (^aDepartment of Biochemical Engineering, School of Chemical Engineering and Technology, Tianjin University, Tianjin 300072, PR China, ^bSchool of Biology and Food Engineering, Harbin University, Harbin 150016, PR China. Corresponding author. Tel.: +86 22 27890492; fax: +86 22 27890492). **Biodegradation of phenol at high initial concentration by *Alcaligenes faecalis*. Journal of Hazardous Materials, Volume 147(1-2) (2007): 672-676**

Strain *Alcaligenes faecalis* was isolated and identified as a member of the genus *Alcaligenes* by using BIOLOG and 16S rDNA sequence analysis. The phenol biodegradation tests showed that the phenol-degrading potential of *A. faecalis* related greatly to the different physiological phases of inoculum. The maximum phenol degradation occurred at the late phase of the exponential growth stages, where 1600 mg L⁻¹ phenol was completely degraded within 76 h. *A. faecalis* secreted and accumulated a vast quantity of phenol hydroxylase in this physiological phase, which ensured that the cells could quickly utilize phenol as a sole carbon and energy source. In addition, the kinetic behavior of *A. faecalis* in batch cultures was also investigated over a wide range of initial phenol concentrations (0–1600 mg L⁻¹) by using Haldane model. It was clear that the Haldane kinetic model adequately described the dynamic behavior of the phenol biodegradation by the strain of *A. faecalis*.

Keywords: Phenol biodegradation; *Alcaligenes faecalis*; Enzyme activity; Kinetics

Muhammad Afzal^a, Samina Iqbal^a, Sakandar Rauf^b and Zafar M. Khalid^a. (^aEnvironmental Biotechnology Division, National Institute for Biotechnology and Genetic Engineering (NIBGE), P.O. Box 577, Jhang Road, Faisalabad, Pakistan, ^bBioprocess Technology Division, National Institute for Biotechnology and Genetic Engineering (NIBGE), P.O. Box 577, Jhang Road, Faisalabad, Pakistan. Corresponding author. Fax: +92 41 2651472). **Characteristics of phenol biodegradation in saline solutions by monocultures of *Pseudomonas aeruginosa* and *Pseudomonas pseudomallei*. Journal of Hazardous Materials, Volume 149(1) (2007): 60-66**

Phenol is a highly toxic and carcinogenic compound and its biodegradation is very important to meet the environmental regulations. Two bacterial strains capable of utilizing phenol as a sole source of carbon were isolated from the wastewater of a pharmaceutical industry. On the basis of morphological and biochemical characteristics these strains were identified as *Pseudomonas aeruginosa* and *Pseudomonas pseudomallei*. Both of these strains were very efficient for phenol degradation. *P. pseudomallei* degraded phenol at a maximum concentration of 1500 mg L⁻¹ within seven days with a specific growth rate of 0.013 h⁻¹ and phenol degradation rate of 13.85 mg L⁻¹ h⁻¹. Maximum initial concentration of phenol utilized by *P. aeruginosa* was 2600 mg L⁻¹ with 0.016 h⁻¹ specific growth rate and 26.16 mg L⁻¹ h⁻¹ phenol degradation rate. Moreover, the effect of various salts i.e., NaCl, KCl, Na₂SO₄ and K₂SO₄ on the growth of these strains and phenol degradation rate (at 1000 mg L⁻¹) was studied. In the presence of these salts, *P. aeruginosa* showed up to 1.53 and 1.34 times faster phenol degradation rate and specific growth rate, respectively as compared to *P. pseudomallei*. In addition, *P. aeruginosa* exhibited higher chemical oxygen demand (COD) and biochemical oxygen demand (BOD) reduction rates as compared to the strain *P. pseudomallei*.

Keywords: Biodegradation; Pharmaceutical industry; Phenol; Salts; Wastewater

Aruliah Rajasekar^a, Sundaram Maruthamuthu^a, Narayanan Palaniswamy^a and Annamalai Rajendran^a. (^a**Biocorrosion, Corrosion Protection Division, Central Electrochemical Research Institute, Karaikudi-630 006, India. Corresponding author. Tel.: +91 4565 227550; fax: +91 4565 227779).** **Biodegradation of corrosion inhibitors and their influence on petroleum product pipeline. Microbiological Research, Volume 162(4) (2007): 355-368**

The present study enlightens the role of *Bacillus cereus* ACE4 on biodegradation of commercial corrosion inhibitors (CCI) and the corrosion process on API 5LX steel. *Bacillus cereus* ACE4, a dominant facultative aerobic species was identified by 16S rDNA sequence analysis, which was isolated from the corrosion products of refined diesel-transporting pipeline in North West India. The effect of CCI on the growth of bacterium and its corrosion inhibition efficiency were investigated. Corrosion inhibition efficiency was studied by rotating cage test and the nature of biodegradation of corrosion inhibitors was also analyzed. This isolate has the capacity to degrade the aromatic and aliphatic hydrocarbon present in the corrosion inhibitors. The degraded products of corrosion inhibitors and bacterial activity determine the electrochemical behavior of API 5LX steel.

Keywords: Diesel pipeline; Corrosion inhibitors; Rotating cage methods; Biodegradation; Microbiologically influenced corrosion

Y. J. Yuan¹, Z. X. Lu¹, L. J. Huang¹, Y. Li¹, F. X. Lu¹, X. M. Bie¹, Y. Q. Teng¹ and Q. Lin¹. (¹**College of Food science and Technology, Nanjing Agricultural University, 1 Weigang, Nanjing, People's Republic of China. Z. X. Lu, Email: fmb@njau.edu.cn).** **Biodegradation of nicotine from tobacco waste extract by *Ochrobactrum intermedium* DN2. Journal of Industrial Microbiology and Biotechnology, Volume 34(8)(2007): 567-570.**

Ochrobactrum intermedium DN2 was used to degrade nicotine in tobacco waste extracts. The optimal temperature and pH of nicotine degradation by strain DN2 was 30–37 °C and 7.0, respectively. Under these optimal conditions, the average degradation rate of nicotine in a 30L fed-batch culture was 140.5 mg l⁻¹ h⁻¹. The results of this study indicate that strain DN2 may be useful for reducing the nicotine content of reconstituted tobacco.

Keywords: Biodegradation - Nicotine - Reconstituted tobacco - *Ochrobactrum intermedium*

M. Estela Silva-Stenico¹, Caryn J. Vengadajellum², Hussnain A. Janjua¹, Sue T. L. Harrison², Stephanie G. Burton² and Don A. Cowan¹. (¹**Advanced Research Centre for Applied Microbiology, Department of Biotechnology, University of the Western Cape, Private Bag X17, Bellville, 7535 Cape Town, South Africa, ²Bioprocess Engineering Research Unit, Department of Chemical Engineering, University of Cape Town, Rondebosch, 7700 Cape Town, South Africa. Don A. Cowan, Email: dcowan@uwc.ac.za).** **Degradation of low rank coal by *Trichoderma atroviride* ES11. Journal of Industrial Microbiology and Biotechnology, Volume 34(9) (2007): 625-631**

A new isolate of *Trichoderma atroviride* has been shown to grow on low rank coal as the sole carbon source. *T. atroviride* ES11 degrades 82% of particulate coal (10 g l⁻¹) over a period of 21 days with 50% reduction in 6 days. Glucose (5 g l⁻¹) as a supplemented carbon source enhanced the coal solubilisation efficiency of *T. atroviride* ES11, while 10 and 20 g l⁻¹ glucose decrease coal solubilisation efficiency. Addition of nitrogen [1 g l⁻¹ (NH₄)₂SO₄] to the medium

also increased the coal solubilisation efficiency of *T. atroviride* ES11. Assay results from coal-free and coal-supplemented cultures suggested that several intracellular enzymes are possibly involved in coal depolymerisation processes some of which are constitutive (phenol hydroxylase) and others that were activated or induced in the presence of coal (2,3-dihydrobiphenyl-2,3-diol dehydrogenase, 3,4-dihydro phenanthrene-3,4-diol dehydrogenase, 1,2-dihydro-1,2-dihydroxynaphthalene dehydrogenase, 1,2-dihydro-1,2-dihydroxyanthracene dehydrogenase). GC-MS analysis of chloroform extracts obtained from coal degrading *T. atroviride* ES11 cultures showed the formation of only a limited number of specific compounds (4-hydroxyphenylethanol, 1,2-benzenediol, 2-octenoic acid), strongly suggesting that the intimate association between coal particles and fungal mycelia results in rapid and near-quantitative transfer of coal depolymerisation products into the cell.

Keywords: Low rank coal - Biodegradation - *Trichoderma atroviride* - Intracellular enzymes

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A cellulase-free xylanase produced by *Bacillus subtilis* C O1 from wheat bran under solid-state cultivation was tested for its efficacy in biobleaching of raw banana fibre and banana pulp obtained through a mechanical pulping process. Banana pulp samples treated with crude xylanase (450 nkat g⁻¹ pulp) resulted in a 19.6% increase in the brightness as compared to untreated pulp. The presence of chromophores, hydrophobic compounds and an increased reducing sugar (10.79 mg g⁻¹ pulp) quantity in the bleached solution after enzymatic treatment indicated the removal of materials that were absorbed at 237 nm from the banana pulp.

Keywords: *Bacillus subtilis* - Solid-state cultivation - Banana pulp - Biobleaching - Brightness

Natalia A. Yemashova¹, Valentina P. Murygina¹, Dmitry V. Zhukov¹, Arpenik A. Zakharyantz¹, Marina A. Gladchenko¹, Vasu Appanna² and Sergey V. Kalyuzhnyi¹. (¹Department of Chemical Enzymology, Chemistry Faculty, Moscow State University, Leninskiye Gory 1-11, Moscow, 119992, Russia, ²Department of Chemistry & Biochemistry, Laurentian University, Ramsey Lake Road, Sudbury, Ontario, Canada, P3E 2C6). Biodeterioration of crude oil and oil derived products: a review. *Reviews in Environmental Science and Biotechnology*, Volume 6(4) (2007): 315-337.

Biodeterioration of crude oil and oil fuels is a serious economic and an environmental problem all over the world. It is impossible to prevent penetration of microorganisms in oil and fuels both stored in tanks or in oilfields after drilling. Both aerobic and anaerobic microorganisms tend to colonise oil pipelines and oil and fuel storage installations. Complex microbial communities consisting of both hydrocarbon oxidizing microorganisms and bacteria using the metabolites of the former form an ecological niche where they thrive. The accumulation of water at the bottom of storage tanks and in oil pipelines is a primary prerequisite for development of microorganisms in fuels and oil and their subsequent biological fouling. Ability of microorganisms to grow both in a water phase and on inter-phase of water/hydrocarbon as well as the generation of products of their metabolism worsen the physical and chemical properties of oils and fuels. This activity

also increases the amount of suspended solids, leads to the formation of slimes and creates a variety of operational problems. Nowadays various test-systems are utilized for microbial monitoring in crude oils and fuels; thus allowing an express determination of both the species and the quantities of microorganisms present. To suppress microbial growth in oils and fuels, both physico-mechanical and chemical methods are applied. Among chemical methods, the preference is given to substances such as biocides, additives, the anti-freezing agents etc that do not deteriorate the quality of oil and fuels and are environmentally friendly. This review is devoted to the analysis of the present knowledge in the field of microbial fouling of crude oils and oil products. The methods utilized for monitoring of microbial contamination and prevention of their undesirable activities are also evaluated. The special focus is given to Russian scientific literature devoted to crude oil and oil products biodeterioration.

Keywords: Biodeterioration - Biofouling - Crude oil - Oil derived products - Microbial contamination control - Biocide

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Intensive use of endosulfan has resulted in contamination of soil and water environments at various sites in Pakistan. This study was conducted to isolate efficient endosulfan-degrading fungal strains from contaminated soils. Sixteen fungal strains were isolated from fifteen specific sites by employing enrichment techniques while using endosulfan as a sole sulfur source, and tested for their potential to degrade endosulfan. Among these fungal strains, *Chaetosartorya stromatoides*, *Aspergillus terricola*, and *Aspergillus terreus* degraded both α - and β -endosulfan upto 75% in addition to 20% abiotic degradation of the spiked amount (100 mg l⁻¹) in the broth within 12 days of incubation. Biodegradation of endosulfan by soil fungi was accompanied by a substantial decrease in pH of the broth from 7.0 to 3.2. The major metabolic product was endosulfan diol along with very low concentrations of endosulfan ether. Maximum biodegradation of endosulfan by these selected fungal strains was found at an initial broth pH of 6, incubation temperature of 30°C and under agitation conditions. This study indicates that the isolated strains carried efficient enzyme systems required for bioremediation of endosulfan-contaminated soil and water environments.

Keywords: Biodegradation -Endosulfan -Fungi - Isolation - pH - Agitation -Temperature

A. M. Brooksbank¹, J. W. Latchford¹ and S. M. Mudge¹. (¹School of Ocean Sciences, University of Wales Bangor, Askew Street, Menai Bridge, Anglesey, LL59 5HN, UK. J. W. Latchford, Email: oss016@bangor.ac.uk). Degradation and modification of fats, oils and grease by commercial microbial supplements. World Journal of Microbiology and Biotechnology, Volume 23(7) (2007): 939-945.

Fats, oils and greases (FOGs) in wastewater create problems including the production of foul odours, the blockage of sewer lines and may interfere with the proper operation of sewage treatment works. Removal of FOG from wastewater is thus critically important to ensure that wastewater is disposed of efficiently and economically. In this study, the ability of commercial microbial supplements to degrade fat/oil under laboratory conditions was investigated. One of

the multi-species supplements examined was capable of significantly enhancing the degradation of several fats and oils by 37–62%, in contrast to all of the single-species supplements which had no significant effect. The multi-species supplement showed no preferential cleavage or degradation of fatty acids in a range of FOGs, whilst wastewater-associated bacteria preferentially degraded octadecatrienoic acid (18:3 ω 3) and octadecadienoic acid (18:2 ω 6). A semi-solid, sticky material, likely to cause blockages in pipework and sewer lines formed when the oil was incubated in the presence of wastewater bacteria. The sticky material was enriched in saturated and mono-unsaturated fatty acids and depleted in polyunsaturated fatty acids relative to the original oil, most likely reflecting preferential fatty acid usage by the bacteria. The production of this semi-solid material by the wastewater bacteria was significantly reduced by the presence of the multi-species product, indicating that commercial supplements have the potential to minimize FOG accumulation and blockages in grease traps and sewer lines as well as enhancing FOG degradation.

Keywords: Bioaugmentation - degradation - fatty acids - grease - wastewater

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A facultative anaerobic species *Serratia marcescens* ACE2 isolated from the corrosion products of a diesel-transporting pipeline in North West India was identified by 16S rDNA sequence analysis. The role of *Serratia marcescens* ACE2 on biodegradation of commercial corrosion inhibitor (CCI) and its influence on the corrosion of API 5LX steel has been enlightened. The degrading strain ACE2 is involved in the process of corrosion of steel API 5LX and also utilizes the inhibitor as organic source. The quantitative biodegradation efficiency of corrosion inhibitor was 58%, which was calculated by gas chromatography mass spectrum analysis. The effect of CCI on the growth of bacteria and its corrosion inhibition efficiency were investigated. Additionally, the role of this bacterium in corrosion of steel has been investigated by powder X-ray diffractometer (XRD) and scanning electron microscope studies. The presence of high-intensity ferric oxides and manganese oxides noticed from the XRD indicates that ACE2 enhances the corrosion process in presence of inhibitor as a carbon source. This basic study will be useful for the development of new approaches for the detection, monitoring and control of microbial corrosion in petroleum product pipelines.

Keywords: *Serratia marcescens* - Petroleum products - Biodegradation - Corrosion inhibitor - Microbiological corrosion

M. N. Shashirekha¹ and S. Rajarathnam¹. (¹Fruit and Vegetable Technology, Central Food Technological Research Institute, Mysore, 570013, India. S. Rajarathnam, Email: rajarathnams@yahoo.com.). **Bioconversion and biotransformation of coir pith for economic production of *Pleurotus florida* : chemical and biochemical changes in coir pith**

during the mushroom growth and fructification. World Journal of Microbiology and Biotechnology, Volume 23(8) (2007): 1107-1114.

Coir pith represents 50% of the waste from the coir industries and was tested for its potential in serving as a growth substrate for the production of species of oyster mushroom, *Pleurotus florida*. Due to its high lignin (48%) content and amorphous powdery nature, coir pith supported poor mushroom mycelial growth and yields were considerably low (25% bioconversion efficiency). Pre-treating coir pith with hot water did not prove economical to produce the mushroom yields. Acid swelling and alkali delignification of coir pith though served to change the structure of coir pith; the mushroom yields were not improved. Amendment of coir pith with rice (*Oryza sativa*) straw and horse gram (*Dolichos biflorus*) plant residue tended to greatly modify the physical characteristics of the inoculated mushroom bed. Such a supplementation of coir pith growth substrate resulted in production of mushroom yields with 110–125% bioconversion efficiency. Implications of supplementing coir pith with rice straw/horse gram plant residue in terms of holocellulose:lignin ratio are discussed. Sensorially, the mushrooms so produced did not differ from that on rice straw, the economic growth substrate recommended for production of the mushroom yields on commercial scale. Changes in cellulose, hemicellulose and lignin contents of coir pith amended with rice straw were studied. Cellulase, hemicellulase and protease enzyme activities in the amended coir pith substrate showed a continuous increase from inoculation till the end of fructification, whereas laccase activity decreased during fructification, in consonance with decreased lignin degradation during fructification.

Keywords: Bioconversion - Biotransformation - BCE (bioconversion efficiency) - Cellulose - Coir pith - Fructification - Hemicellulose - Holocellulose - Lignin - Oyster mushroom - *Pleurotus florida* - Spawn run

Sunday A. Adebuseye¹, Matthew O. Ilori¹, Olukayode O. Amund¹, Olakunle D. Teniola² and S. O. Olatope². (¹Faculty of Science, Department of Botany and Microbiology, University of Lagos, Akoka, Yaba, Lagos, Nigeria, ²Biotechnology Division, Federal Institute of Industrial Research, Oshodi, Lagos, Nigeria. Corresponding author: Sunday A. Adebuseye, Email: sadebusoye@yahoo.com, Olakunle D. Teniola, Email: olakunleteniola@yahoo.com). Microbial degradation of petroleum hydrocarbons in a polluted tropical stream. World Journal of Microbiology and Biotechnology, Volume 23(8) (2007): 1149-1159.

Crude oil degradation was observed in water samples from three sites along the course of a polluted stream in Lagos, Nigeria. Consistent increase and decrease in the total viable counts (TVCs) of indigenous organisms occurred in the test and control experiments, respectively. Enrichments of the water samples with crude oil resulted in the isolation of nine bacteria belonging to seven genera. A mixed culture was developed from the assemblage of the nine species. The defined microbial consortium utilized a wide range of pure HCs including cycloalkane and aromatic HCs. Utilization of crude oil and petroleum cuts, i.e., kerosene and diesel resulted in an increase in TVC (till day 10) concomitant with decreases in pH and residual oil concentration. Crude oil, diesel and kerosene were degraded by 88, 85 and 78%, respectively, in 14 days. Substrate uptake studies with axenic cultures showed that growth was not sustainable on either cyclohexane or aromatics while degradation of the petroleum fractions fell below 67% in spite of extended incubation period (20 day). From the GC analysis of recovered oil, while reductions in peaks of *n*-alkane fractions and in biomarkers namely *n*-C₁₇/pristane and *n*-C₁₈/phytane ratios were observed in culture fluids of pure strains, complete removal of all the

HC components of kerosene, diesel and crude oil including the isoprenoids was obtained with the consortium within 14 days.

Keywords: Bacteria - Degradation - Hydrocarbons - Phytane - Pristane - Residual oil

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Polychlorinated biphenyls (PCBs) in Kanechlor-300 and -400 mixtures dissipated significantly compared with a sterilized control under anaerobic conditions in three Japanese paddy soils with no history of PCB contamination, demonstrating the anaerobic microbial degradation of PCBs. The PCB-degrading activity was maintained successfully in a static flooded soil medium for more than 3 years by serial transfer at intervals of 56 days (13 transfers). *Ortho*-, *meta*-, and *para*-substituted PCBs, 15.2 ± 9.9 mol% in total, were significantly degraded after 56 days of incubation. Analysis of menaquinones-6 and -7 and cloning of 16S rRNA gene fragments from a polymerase chain reaction denaturing gradient gel electrophoresis (DGGE) profile indicated the predominance of *Firmicutes* in the consortium. A PCR-based identification of the gene fragments showed the frequent presence of *Desulfitobacterium* sp., but not *Dehalobacter* sp. or *Dehalococcoides* sp., in the consortium. It is proposed that Japanese paddy soils with no history of PCB contamination contain an anaerobic microbial consortium consisting predominantly of *Firmicutes* that have the potential for anaerobic degradation of PCB.

Keywords: Anaerobic microbial degradation - Dechlorination - Polychlorinated biphenyls - Paddy soils - Activity maintenance - Microbial consortium - *Firmicutes*

Anis Shobirin Meor Hussin¹, Abd-ElAzim Farouk¹, Ralf Greiner², Hamzah Mohd Salleh¹ and Ahmad Faris Ismail¹. (¹Biomolecular Engineering Research Unit, Department of Biotechnology Engineering, International Islamic University Malaysia, Jalan Gombak, 53100 Kuala Lumpur, Malaysia, ²Centre for Molecular Biology, Federal Research Centre for Nutrition and Food, Haid-und-Neu Strasse 9, 76131 Karlsruhe, Germany. Abd-ElAzim Farouk, Email: farouk@iiu.edu.my). Phytate-degrading enzyme production by bacteria isolated from Malaysian soil. *World Journal of Microbiology and Biotechnology*, Volume 23(12) (2007): 1653-1660

Over two hundred bacteria were isolated from the halosphere, rhizosphere and endophyte of Malaysian maize plantation and screened for phytases activity. Thirty isolates with high detectable phytase activity were chosen for media optimization study and species identification. Ten types of bacterial phytase producers have been discovered in this study, which provides opportunity for characterization of new phytase(s) and various commercial and environmental applications. The majority of the bacterial isolates with high detectable phytase activity were of endophyte origin and 1.6% of the total isolates showed phytase activity of more than 1 U/ml.

Most of the strains produced extra-cellular phytase and *Staphylococcus lentus* ASUIA 279 showed the highest phytase activity of 1.913 U/ml. All 30 species used in media optimization study exhibit favorable enzyme production when 1% rice bran was included in the growth media.

Keywords: Screening - phytase - *Zea mays* - Soil bacteria - Media optimization

Biosensor

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The aim of this review is to summarize the most relevant contributions in the development of electrochemical (bio)sensors based on carbon nanotubes in the last years. Since the first applications of carbon nanotubes in the preparation of an electrochemical sensor, an increasing number of publications involving carbon nanotubes,-based sensors have been reported, demonstrating that the particular structure of carbon nanotubes and their unique properties make them a very attractive material for the design of electrochemical biosensors.

The advantages of carbon nanotubes to promote different electron transfer reactions, in special those related to biomolecules; the different strategies for constructing carbon nanotubes-based electrochemical sensors, their analytical performance and future prospects are discussed in this article.

Keywords: Carbon nanotubes; Enzymes; DNA; Antigen; Antibody; DNA biosensor; Enzymatic biosensor; Immunosensor

Donatella Carelli, Diego Centonze*, Carmen Palermo, Maurizio Quinto, Taddeo Rotunno. (DiSACD-Dipartimento di Scienze Agro-ambientali, Chimica e Difesa Vegetale and BIOAGROMED, Università degli Studi di Foggia, via Napoli, 25-71100 Foggia, Italy). **An interference free amperometric biosensor for the detection of biogenic amines in food products. Biosensors and Bioelectronics Vol. 23(2007): 640 – 647.**

In this work is reported the development and application of an amperometric biosensor for the determination of total biogenic amines content by using the commercial diamino oxidase (DAO from Porcine Kidney E.C. 1.4.3.6) as the biocomponent, entrapped by glutaraldehyde onto an electrosynthesized bilayer film.

In order to minimize both the fouling and the interference caused by the direct electrochemical oxidation of both the analytes (i.e., biogenic amines) and the common interferents usually

present in food products the performances of Pt and Au electrodes and of several electroproduced anti-interferents mono- and bi-layer films were tested.

In spite of a very low activity of the commercial DAO, the biosensor displayed a high response sensitivity in flow experiments, short response time, a good linear response and low detection limits. The excellent anti-interference characteristics allowed that use of the biosensor in screening analysis of food products.

Keywords: Amperometric biosensors; Diamino oxidase; Biogenic amines; Permselective films; Platinum electrode; Flow injection analysis.

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An electrochemical DNA biosensor (EDB) was prepared using an oligonucleotide on 21 bases with sequence NH₂-5'- GAGGAGTTGGGGGAGCACATT-3' (probe DNA) immobilized on a novel multinuclear nickel(II) salicylaldimine metallodendrimer on glassy carbon electrode (GCE). The metallodendrimer was synthesized from amino functionalized polypropylene imine dendrimer, DAB – (NH₂)₈. The EDB was prepared by depositing probe DNA on a dendrimer-modified GCE surface and left to immobilize for 1 h. voltammetric and electrochemical impedance spectroscopic (EIS) studies were carried out to characterize the novel metallodendrimer, the EDB and its hybridization response in PBS using [Fe(CN)₆]^{3-/4-} as a redox probe at pH 7.2. The metallodendrimer was electroactive in PBS with two reversible redox couples at E¹ = ± 200 mV and E¹ = ± 434 mV; catalytic by reducing the E_{pa} of [Fe(CN)₆]^{3-/4-} by 22 mV; conducting and has diffusion coefficient of 8.597 X10⁻⁸ cm² s⁻¹. from the EIS circuit fitting results, the EDB responded to 5 nM target DNA by exhibiting a decrease in charge transfer resistance (R_{ct}) in PBS and increase in R_{ct} in [Fe(CN)₆]^{3-/4-} redox probe; while in voltammetry, increase in peak anodic current was observed in PBS after hybridization, thus giving the EDB a dual probe advantage.

Keywords: Dendrimer; Metallodendrimer; Electrochemical DNA biosensor; Immobilization Electrochemical impedance spectroscopy

Bioengineering

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Dipartimento di Scienze Chimiche e Ambientali, Università dell'Insubria, Como, Italy⁵*Corresponding author. Mailing address: Dipartimento di Scienze e Tecnologie Alimentari e Microbiologiche, Università degli Studi di Milano, Via Celoria 2, 20133 Milano, Italy. Phone: 39-0250319121. Fax: 39-0250319238. E-mail: francesca.cappitelli@unimi.it). Advantages of Using Microbial Technology over Traditional Chemical Technology in Removal of Black Crusts from Stone Surfaces of Historical Monuments⁵. Applied and Environmental Microbiology, Vol. 73(17) (2007): 5671-5675,

This study compares two cleaning methods, one involving an ammonium carbonate-EDTA mixture and the other involving the sulfate-reducing bacterium *Desulfovibrio vulgaris* subsp. *vulgaris* ATCC 29579, for the removal of black crust (containing gypsum) on marble of the Milan Cathedral (Italy). In contrast to the chemical cleaning method, the biological procedure resulted in more homogeneous removal of the surface deposits and preserved the patina noble under the black crust. Whereas both of the treatments converted gypsum to calcite, allowing consolidation, the chemical treatment also formed undesirable sodium sulfate.

Sabria Barka. (¹Laboratoire de Toxicologie Marine et Environnementale, UR 09-03, Université de Sfax, IPEIS, BP 805, 3018 Sfax, Tunisia, Author: Sabria Barka Email: sabriabarka2@yahoo.fr). Insoluble detoxification of trace metals in a marine copepod *Tigriopus brevicornis* (Muller) exposed to copper, zinc, nickel, cadmium, silver and mercury. Ecotoxicology, Volume 16 (7) (2007): 491-502

The marine harpacticoid copepods *Tigriopus brevicornis* were collected along the French Atlantic Coast (Loire Atlantique) and subsequently exposed to different lethal and sublethal concentrations of various metals (copper, zinc, nickel, cadmium, silver and mercury) for varying lengths of time. Ultrastructural investigations of control and experimentally exposed copepods were performed to investigate the intracellular localization of metals using transmission electronic microscopy (TEM). Copepod digestive epithelium cells as well as the cuticular integument were found to be the major metal storage tissues. Different types of metal-containing granules were found in both metal-exposed copepods and the controls: (1) within lysosomes, (2) in intracellular calcospherites and (3) in extracellular tiny granules. The elemental composition of the granules was determined on ultrathin sections by means of energy dispersive X-ray spectroscopy (EDS). The results were interpreted by considering previous data in order to understand how *Tigriopus brevicornis* copes with the presence of metals in its environment.

Keywords: Copepod - Crustacea - Detoxification - Granules - Metals - Ultrastructure - X-ray microanalysis

HongLi Yuan¹, ZhiJian Li¹, JiaoYan Ying¹ and EnTao Wang². (¹College of Biological Sciences, Key Laboratory of Agro-Microbial Resource and Application, Ministry of Agriculture, China Agricultural University, 100094 Beijing, China, ²Departamento de Microbiología, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional, México D. F., México. HongLi Yuan, Email: hlyuan@cau.edu.cn). Cadmium(II) Removal by a Hyperaccumulator Fungus *Phoma* sp. F2 Isolated from Blende Soil. Current Microbiology, Volume 55(3) (2007): 223-227.

A cadmium(II)-resistant fungus, strain F2, isolated from blende soil was identified as *Phoma* sp. by morphological study and internal transcribed spacer sequencing. This strain could accumulate

280 mg of Cd(II)/g dry weight mycelium. In liquid medium containing 163.8 mg Cd(II)/L, 96% of Cd(II) was removed by the actively growing mycelium. In addition, both oven-dried and lyophilized mycelium could effectively adsorb Cd(II). There were removed 91% and 46.2% of Cd(II) from 51.6 mg Cd(II)/L solution by lyophilized biomass and oven-dried biomass respectively. Transmission electron microscopy and energy-dispersive X-ray analysis showed the accumulation of Cd(II) in the mycelium cell walls. Our results demonstrated that *Phoma* sp. F2 was a hyperaccumulator for the removal of Cd(II) from contaminated soil and water.

Keywords Biosorption - Cd(II) - ITS - Imperfect fungus

K. Vijayaraghavan^a, Min Hee Han^a, Sun Beom Choi^a and Yeoung-Sang Yun^a. (^aDivision of Environmental and Chemical Engineering, Research Institute of Industrial Technology, Chonbuk National University, Chonju 561-756, South Korea. Corresponding authors. Tel.: +82 63 270 2308; fax: +82 63 270 2306). **Biosorption of Reactive black 5 by *Corynebacterium glutamicum* biomass immobilized in alginate and polysulfone matrices. *Chemosphere*, Volume 68(10) (2007): 1838-1845**

Corynebacterium glutamicum, a lysine fermentation industry waste, showed promise for the removal of Reactive black 5 (RB5). Due to practical difficulties in solid-liquid separation, the free biomass was immobilized in two polymer matrices: calcium alginate and polysulfone. Initially, the optimization of biomass loading in polymeric beads and bead dosage were examined. Of the different combinations examined, 4% (with bead dosage of 2 g per 40 ml) and 14% (with bead dosage of 1 g per 40 ml) in the case of alginate and polysulfone beads, respectively, were identified as the optimal conditions. According to the Langmuir model, at pH 1, the maximum RB5 uptakes of 352, 282 and 291 mg g⁻¹ were observed for free, alginate and polysulfone-immobilized biomass, respectively. According to the Weber-Morris model, intraparticle diffusion was found to be the potential rate limiting step for the immobilized beads. Regeneration experiments, with 0.01 M NaOH and Na₂CO₃ as eluents, revealed that polysulfone beads exhibited invariable RB5 uptake capacity and very high mechanical stability even at the end of twentieth cycle, confirming the technical feasibility of the biosorption process for industrial applications.

Keywords: Biomass immobilization; Isotherm; Kinetics; Regeneration; Wastewater treatment

Paula Guerra^a, Inés Ahumada^a and Adriana Carrasco^b. (^aFacultad de Cs. Químicas y Farmacéuticas, Universidad de Chile, Casilla 233, Santiago, Chile, ^bFacultad de Cs. Agronómicas, Universidad de Chile, Casilla 1004, Santiago, Chile. Corresponding author. Tel.: +56 2 9782802; fax: +56 2 7370567). **Effect of biosolid incorporation to mollisol soils on Cr, Cu, Ni, Pb, and Zn fractionation, and relationship with their bioavailability. *Chemosphere*, Volume 68(11) (2007): 2021-2027**

Biosolid application to soil may be a supply of nutrients and micronutrients but it may also accumulate toxic compounds which would be absorbed by crops and through them be incorporated to the trophic chain.

The present study deals with the effect of biosolid application on Cr, Cu, Pb, Ni, and Zn in agricultural soils. The procedure used is sequential extraction so that the availability of those metals may be estimated and related to their bioavailability as determined through two indicator plants grown in greenhouse: ryegrass (*Lolium perenne* L.) and red clover (*Trifolium pratense*).

Results showed that biosolid application to soil increased total Cu and Zn content. Sequential extraction showed that the more labile Zn fractions increased after biosolid application to soil. This was confirmed when assessing the total content of this metal in shoot and root of the plants under study, since a higher content was found in plant tissues, while no significant differences were found for Cu, Cr, Ni, and Pb.

Keywords: Biosolids; Metals; Bioavailability; Sequential extraction

A. Doubla^a, S. Laminsi^a, S. Nzali^a, E. Njoyim^a, J. Kamsu-Kom^a and J.-L. Brisset^b. (^aInorganic Chemistry Laboratory, University of Yaounde I, P.O. Box 812, Yaounde, Cameroon, ^bLaboratoire d'Électrochimie (L.E.I.C.A.), UFR des Sciences de l'Université de Rouen, 76821 Mont Saint-Aignan, France. Corresponding author. Present address: Université de Rouen, Laboratoire de Microbiologie Du Froid (UPRES.A 2123), 55 rue St. Germain, 27000 Evreux, France. Tel./fax: +33 235146658). **Organic pollutants abatement and biodecontamination of brewery effluents by a non-thermal quenched plasma at atmospheric pressure. Chemosphere, Volume 69(2) (2007): 332-337**

A preliminary study was carried out to investigate possible decontamination of the waste waters from a Cameroonian brewery by using a non-thermal atmospheric plasma. Samples of waste waters collected during periods of intense activity of production were first analysed for organoleptic, physical-chemical and organic parameters, and then exposed to a humid air electric discharge at ambient temperature and pressure. The resultant pollution abatement and germicidal effects are both ascribed to strong oxidising effects of OH and NO radicals formed in the plasma. The BOD removal efficiency of the process with brewery industrial wastewaters under BOD concentration of 385 and 1018 mg l⁻¹ were 74% and 98% respectively. The alkaline wastewaters are rapidly neutralised due to the pH lowering effects of the plasma treatment.

Keywords: Non-thermal plasma; Wastewaters; Brewery; Organic pollutants abatement; Biodecontamination

Kumud Kumari^a and T. Emilia Abraham^{1, a}. (^aRegional Research Laboratory, Council for Scientific and Industrial Research, Thiruvananthapuram, Kerala 695 019, India. Corresponding author. Present address: Diabetes Research Laboratories, Room # 513, Massachusetts General Hospital, Harvard Medical School, 65 Landsdowne Street, Cambridge, MA 02139, USA. Tel.: +1 617 768 8437; fax: +1 617 768 8888, ¹ Tel.: +91 471 2515253; fax: +91 471 2490186). **Biosorption of anionic textile dyes by nonviable biomass of fungi and yeast. Bioresource Technology, Volume 98(9) (2007): 1704-1710**

The nonviable biomass of *Aspergillus niger*, *Aspergillus japonica*, *Rhizopus nigricans*, *Rhizopus arrhizus*, and *Saccharomyces cerevisiae* were screened for biosorption of textile dyes. The selected anionic reactive dyes were C.I. Reactive Black 8, C.I. Reactive Brown 9, C.I. Reactive Green 19, C.I. Reactive Blue 38, and C.I. Reactive Blue 3. Experiments were conducted at initial dye concentration of 50, 100, 150 and 200 mg/L. The effect of initial dye concentration, dose of biosorbent loading, temperature, and pH on adsorption kinetics was studied. *S. cerevisiae* and *R. nigricans* were good biosorbents at initial dye concentration of 50 mg/L, 1 g% (w/v) biomass loading and 29 ± 1 °C. *R. nigricans* adsorbed 90–96% dye in 15 min, at 20 °C and pH 6.0. The data showed an optimal fit to the Langmuir and Freundlich isotherms. The maximum uptake capacity (Q^o) for the selected dyes was in the range 112–204 mg/g biomass.

Keywords: Reactive anion dyes; Textile effluent; Biosorption; Fungi; Adsorption kinetics

Further reading

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O. Yesilda, S. Cing and D. Asma, Decolorization of the textile dye astrazon red fbl by *funalia tragii* pellets, *Bioresource Technol.* **81** (2002) (2), pp. 155–157.

V. Dritsa^a, F. Rigas^a, K. Natsis^a and R. Marchant^b. (^aNational Technical University of Athens, School of Chemical Engineering, 15700 Athens, Greece, ^bUniversity of Ulster, School of Biological and Environmental Sciences, N. Ireland, UK. Corresponding author. Fax: +30 2107723163). **Characterization of a fungal strain isolated from a polyphenol polluted site. *Bioresource Technology*, Volume 98(9) (2007): 1741-1747**

A group of fungal strains were isolated from a polyphenol polluted soil, taken from an olive oil processing plant in Attica, Greece. The fungi were tested for their ability to decolorize a polyaromatic dye Poly R-478, which was used as a model compound to test their ligninolytic activities. The strain K1.1 decolorized efficiently the dye on agar plates and was further studied. PCR amplification of the internal transcribed spacer (ITS) region of the ribosomal RNA genes from the genomic DNA isolated from mycelium grown in liquid culture resulted in amplified fragments. Via BLASTN search, the length of a 773 base pairs was identified as the basidiomycetes *Coprinellus xanthothrix*. The growth rates and the tolerance of the fungus were compared on solid media, containing four different concentrations of pentachlorophenol. Extracellular enzyme activities (lignin peroxidase, manganese peroxidase and laccase) were determined in defined liquid medium. The isolate expressed laccase and manganese peroxidase but not lignin peroxidase. The removal of the dye was also estimated in liquid medium. The fungus showed biosorption and biotransformation as removal mechanisms.

Keywords: Basidiomycetes; Biotransformation; Bioremediation; Biosorption; PCR

Anuj Kumar Chandel^a, Rajeev Kumar Kapoor^a, Ajay Singh^b and Ramesh Chander Kuhad^a. (^aLignocellulose Biotechnology Laboratory, Department of Microbiology, University of Delhi South Campus, Benito Juarez Marg, New Delhi 110 021, India, ^bDepartment of Biology, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1. Corresponding author. Tel.: +91 09871509870/11 24112972; fax: +91 11 24115270). **Detoxification of sugarcane bagasse hydrolysate improves ethanol production by *Candida shehatae* NCIM 3501. *Bioresource Technology*, Volume 98(10) (2007): 1947-1950**

Sugarcane bagasse hydrolysis with 2.5% (v/v) HCl yielded 30.29 g/L total reducing sugars along with various fermentation inhibitors such as furans, phenolics and acetic acid. The acid hydrolysate when treated with anion exchange resin brought about maximum reduction in furans (63.4%) and total phenolics (75.8%). Treatment of hydrolysate with activated charcoal caused 38.7% and 57.5% reduction in furans and total phenolics, respectively. Laccase reduced total phenolics (77.5%) without affecting furans and acetic acid content in the hydrolysate. Fermentation of these hydrolysates with *Candida shehatae* NCIM 3501 showed maximum ethanol yield (0.48 g/g) from ion exchange treated hydrolysate, followed by activated charcoal (0.42 g/g), laccase (0.37 g/g), overliming (0.30 g/g) and neutralized hydrolysate (0.22 g/g).

Keywords: *Candida shehatae*; Acid hydrolysis; Detoxification; Ethanol; Laccase

Deepak Pant^a and Alok Adholeya^{a, b}. (^aCentre of Bioresources and Biotechnology, TERI University, DS Block, India Habitat Centre, Lodhi Road, New Delhi 110 003, India, ^bBiotechnology and Management of Bioresources Division, The Energy and Resources Institute, DS Block, India Habitat Centre, Lodhi Road, New Delhi 110 003, India. **Corresponding author. Address: Biotechnology and Management of Bioresources Division, The Energy and Resources Institute, DS Block, India Habitat Centre, Lodhi Road, New Delhi 110 003, India. Tel.: +91 11 24682100/24682111; fax: +91 11 24682144/24682145). Biological approaches for treatment of distillery wastewater: A review. *Bioresource Technology*, Volume 98(12) (2007): 2321-2334**

Effluent originating from distilleries known as spent wash leads to extensive soil and water pollution. Elimination of pollutants and colour from distillery effluent is becoming increasingly important from environmental and aesthetic point of view. Stillage, fermenter and condenser cooling water and fermenter wastewater are the primary polluting streams of a typical distillery. Due to the large volumes of effluent and presence of certain recalcitrant compounds, the treatment of this stream is rather challenging by conventional methods. Therefore, to supplement the existing treatments, a number of studies encompassing physico-chemical and biological treatments have been conducted. This review presents an account of the problem and the description of colour causing components in distillery wastewater and a detailed review of existing biological approaches. Further, the studies dealing with pure cultures such as bacterial, fungal, algal and plant based systems have also been incorporated. Also, the roles of microbial enzymes in the decolorization process have been discussed to develop a better understanding of the phenomenon.

Keywords: Colour removal; Distillery effluent; Enzymes; Melanoidin; Microorganisms; Wastewater treatment

Salony, S Mishra & V S Bisaria. Decolorization and detoxification of textile dyes and black liquor by laccase of *Cyathus bulleri*. *Journal of Scientific & Industrial Research*, Volume 66 (8) (2007): 680

A number of direct, vat, basic and other (Ranomill yellow and Texacid fast red A) dyes have been decolorized using concentrated culture filtrate and purified laccase of white-rot fungus *Cyathus bulleri*. Decolorization (>50%) was achieved using culture filtrate in 2-9 days, which was significantly reduced with purified laccase of high specific activity (4022 U/mg protein). Addition of ABTS {2, 2'-azinobis (3-ethylthiazoline-6-sulfonate)} resulted in further reduction of time to a few hours with decolorization rates from 260 mg l⁻¹ day⁻¹ to 665 mg l⁻¹ day⁻¹. Decolorization was accompanied by detoxification, as shown in growth inhibition experiments with *Bacillus subtilis*. Addition of fungal mycelium to suitably diluted black liquor resulted in significant (60-80%) reduction in color in 3-4 days indicating suitability of this fungus for treatment of paper mill wastes.

Ting Liu¹, Huidong Li¹, Zhao Li¹, Xiao Xiao¹, Lingli Chen¹ and Le Deng¹. (¹Department of Microbiology, Hunan Normal University, Changsha, Hunan, 410081, P.R. China. Le Deng, Email: DengLe@hunnu.edu.cn). Removal of hexavalent chromium by fungal biomass of *Mucor racemosus* : influencing factors and removal mechanism. *World Journal of Microbiology and Biotechnology*, Volume 23(12) (2007): 1685-1693

This study reported the hexavalent chromium removal by untreated *Mucor racemosus* biomass and the possible mechanism of Cr (VI) removal to the biomass. The optimum pH, biomass dose, initial Cr (VI) concentration and contact time were investigated thoroughly to optimize the removal condition. The metal removal by the biomass was strongly affected by pH and the optimum pH ranged from 0.5 to 1.0. The residual total Cr was determined. It was found that dichromate reduction occurred at a low very low pH value. At biomass dose 6 g/l, almost all the Cr (VI) ions were removed in the optimum condition. Higher removal percentage was observed at lower initial concentrations of Cr (VI) ions, while the removal capacity of the biomass linearly depended on the initial Cr (VI) concentration. More than half of Cr (VI) ions were diminished within 1 h of contact and removal process reached a relative equilibrium in approximately 8 h. Almost all of the Cr (VI) ions were removed in 24 h when initial concentrations were below 100 mg/l. The equilibrium data were fitted in to the Langmuir and the Freundlich isotherm models and the correlated coefficients were gained from the models. A Fourier transform infrared spectra was employed to elucidate clearly the possible biosorption mechanism as well.

Keywords: Biosorption - Reduction - Cr (VI) - Isotherm models - *Mucor racemosus*

Juliano Garavaglia¹, Simone Hickmann Flôres¹, Tania Mara Pizzolato², Maria do Carmo Peralba² and Marco Antônio Záchia Ayub¹. (¹Food Science and Technology Institute, Federal University of Rio Grande do Sul State, Av. Bento Gonçalves, 9500, 15090, Porto Alegre, 91501-970, RS, Brazil, ²Chemistry Institute, Federal University of Rio Grande do Sul State, Av. Bento Gonçalves, 9500, 15090, Porto Alegre, 91501-970, RS, Brazil. Marco Antônio Záchia Ayub, Email: mazayub@ufrgs.br). **Bioconversion of L-phenylalanine into 2-phenylethanol by *Kluyveromyces marxianus* in grape must cultures. World Journal of Microbiology and Biotechnology, Volume 23(9) (2007): 1273-1279**

A 2³ factorial design was employed to find the best conditions of pH, L-phenylalanine concentration and temperature for the production of 2-phenylethanol by *Kluyveromyces marxianus* CBS 6556. The cultivation was carried out on grape must, which contains a great amount of nitrogen compounds. Central composite design (CCD) was used for the analysis of treatment combinations. Results showed a second-degree polynomial regression model with good agreement of experimental data, with $R^2 = 0.92015$ ($p < 0.05$). The maximum production of 2-phenylethanol was found at pH 7.0, temperature of 37 °C, and a concentration of 3.0 g of L-phenylalanine L⁻¹. Further experiments in bioreactors showed that oxygen concentration is also important to 2-phenylethanol production, with best results obtained at oxygen mass transfer rates of 2.0 h⁻¹.

Keywords: 2-Phenylethanol - Experimental design - Food flavours - Grape must - *Kluyveromyces marxianus*.

Jasvir IS Khattar *, Tangirala A Sarma, Anuradha Sharma. (Department of Botany, Punjabi University, Patiala, India. email: Jasvir IS Khattar (jisk_pbi@rediffmail.com). Correspondence to Jasvir IS Khattar, Department of Botany, Punjabi University, Patiala - 147 002, India). **Optimization of chromium removal by the chromium resistant mutant of the cyanobacterium *Anacystis nidulans* in a continuous flow bioreactor. Journal of Chemical Technology & Biotechnology, Volume 82(7) (2007): 652 – 657**

BACKGROUND: Chromium removal potential of the cyanobacterium *Anacystis nidulans* and its chromium resistant strain Cr^rI8 has been optimized. Optimized parameters include biomass load, pH, temperature and dilution rate of the bioreactor.

RESULTS: Results show that chromium resistant strain has high EC₅₀ dose for chromium compared to wild strain. Chromium removal potential of both strains is strongly influenced by various factors. Optimized conditions in batch system included pH 6.5, temperature 28 °C, biomass load 150 µg protein mL⁻¹ for 30 µmol L⁻¹ Cr⁶⁺ solution. In continuous flow bioreactor at optimum pH (6.5) and temperature (28 °C) at a fixed biomass of 10 mg protein and 30 µmol L⁻¹ Cr⁶⁺, metal removal efficiency varied with dilution rate. For *A. nidulans* continuous flow bioreactor, optimum dilution rate was 0.076 h⁻¹ (64.6 per cent metal removal) while for Cr^rI8 it was 0.152 h⁻¹ (85.8 per cent metal removal). Operative time of the Cr^rI8 bioreactor was also more (85 h) compared to *A. nidulans* bioreactor (45 h).

CONCLUSION: Under optimized conditions resistant strain Cr^rI8 removed more Cr⁶⁺ compared to *A. nidulans* and thus has the potential to be exploited for Cr⁶⁺ removal from industrial effluents at large scale.

Keywords: chromium removal • optimum conditions • continuous flow bioreactor • cyanobacterium • *Anacystis nidulans* • resistant strain

Pollen Biotechnology

N. Futamura^a, Y. Kusunoki^b, Y. Mukai^b, K. Shinohara^a. (^aDepartment of Molecular and Cell Biology, Forestry and Forest Products Research Institute, Ibaraki, and, ^bFaculty of Agriculture, Shizuoka University, Shizuoka, Japan E-Mail futa@ffpri.affrc.go.jp). **Characterization of Genes for a Pollen Allergen, Cry j 2, of *Cryptomeria japonica*. Allergy and Immunology, Vol. 143(1) (2007): 59-68**

Background: Cry j 2 is one of the major pollen allergens of *Cryptomeria japonica*. The polymorphism of Cry j 2 isoforms and the conservation of the structure of Cry j 2 in coniferous species remain to be analyzed. *Methods:* A cDNA library derived from the pollen of *C. japonica* was screened using a fragment of Cry j 2 cDNA. Restriction fragment length polymorphism analysis was performed to examine the diversity of Cry j 2 genes. The promoters of Cry j 2 genes were isolated with a commercially available cloning kit. Clonal variations in the expression of Cry j 2 in pollen were examined by RNA gel blot analysis, and the conservation of the structure of the Cry j 2 gene in coniferous species was evaluated by DNA gel blot analysis. *Results:* We isolated three cDNA clones encoding novel isoforms of Cry j 2. We also sequenced a total of 16 promoter regions from 10 specimens. The sequences of promoter regions of Cry j 2 genes were highly divergent. The amount of Cry j 2 mRNA also varied considerably. The Cry j 2 gene was found to be conserved among species belonging to Taxodiaceae and Cupressaceae but to vary between Taxodiaceae and Pinaceae. *Conclusions:* The coding and promoter regions of Cry j 2 genes contain large numbers of polymorphisms. Our analysis revealed large variations in the expression of Cry j 2 at the transcriptional level, and we suggest that conserved homologs of Cry j 2 confer cross-allergenicity among Taxodiaceae and Cupressaceae.

Key Words:

- Pollen allergen
- *Cryptomeria japonica*
- Cry j 2 gene
- Polymorphism
- Gene expression
- Clonal variation
- Cross-allergy
- Coniferous species

Bohle, B. The impact of pollen-related food allergens on pollen allergy. *Allergy*, Vol. 62(1) (2007): 3-10(8)

Patients with birch pollen allergy frequently develop hypersensitivity reactions to certain foods, e.g. apples, celery, carrots and hazelnuts. These reactions are mainly caused by IgE-antibodies specific for the major birch pollen allergen, Bet v 1, which cross-react with homologous proteins in these foods. Analyzing the T-cell response to Bet v 1-related food allergens revealed that these dietary proteins contain several distinct T-cell epitopes and activate Bet v 1-specific T cells to proliferate and produce cytokines. Several of these cross-reactive T-cell epitopes were not destroyed by simulated gastrointestinal digestion of food allergens and stimulated Bet v 1-specific T cells despite nonreactivity with IgE antibodies. Similarly, cooked food allergens did not elicit IgE-mediated symptoms (oral allergy syndromes) but caused T-cell-mediated late-phase reactions (deterioration of atopic eczema) in birch pollen-allergic patients with atopic dermatitis because thermal processing affected their conformational structure and not the primary amino acid sequence. Thus, T-cell cross-reactivity between Bet v 1 and related food allergens occurs independently of IgE-cross-reactivity *in vitro* and *in vivo*. We speculate that symptom-free consumption of pollen-related food allergens may have implications for the pollen-specific immune response of allergic individuals.

Keywords: Bet v 1; birch pollen allergy; cross-reactivity; food allergy; T cells

Biotechnology Policy Issue

M.H.Fulekar. (Department of Life Science, University of Mumbai, Mumbai. Email: mhfulekar@yahoo.com). *Environmental Nanotechnology. Environment: Science & Engineering*, Vol. 5 (2) (2007): 65-75.

The global society in the 21st Century is facing the challenges of improving the quality of air, water and soil environment and maintaining the ecological balance. The pollution load from various sources viz. industrial wastes, domestic wastes, pesticides and fertilizers, automobile emissions, particulate matter and gaseous pollutants, municipal and industrial solid wastes get accumulated in the environment. The impact of the pollutants on the environment will be

significant when the accumulated pollution load had exceeded the carrying capacity of the receiving environment.

Man-environment relationship has a social origin. The modern technological advancements had given rise to new breed of products and new pollutants. Detecting, detoxifying the pollutants and minimization of waste are among the challenges, the industries have been left to face with. The remediation of contaminants by use of the existing technologies will not be effective enough to meet the futuristic environmental standards and needs innovative application of advanced technologies. Environmental nanotechnology would be a new technological innovation to remediate and treat the contaminants to the acceptable levels. Environmental scientists and engineers are already working with Nano-scale structure to manipulate matter to the atomic or molecular scale that has cut across disciplines of chemistry, physics, biology and even engineering. Natural weathering of minerals, iron oxides and silicate and microorganisms such as bacteria and algae produce nano celluloids, which include dispersions of Nano-sized particles in media with special properties that can be important in the transport, transformation and bioavailability of environmentally harmful substances. Nanotechnology offers great promise for delivering new and improved environmental technologies.

Agricultural Biotechnology

Rehana Qudir, G. Nazir, K. Hussain and Asif Mohd. (Division of Plant Breeding Genetics, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir. Shalimar 191 121, India). Biotechnological Approaches for Quality Improvement in Crop Plants. *Environment & Ecology* 25S (3A) (2007): 899 – 904.

Plant breeders have been extremely successful in improving the quality and yield of the major crops, while maintaining the safety of the food supply. This success has been achieved with very little understanding of the biochemical mechanisms that determine the selected traits. Each time a cross is made, tens of thousands of genes are mixed and reassorted, largely at random. With the advent of recombinant DNA technology, breeders have not only extended the range of biological materials from which genes can be accessed, but have also gained new insights into genome organization and gene structure and the nature and function of the proteins that those genes encode. Such knowledge affords exquisite specificity in altering the genetic makeup of new crop varieties. The technology also affords unique opportunities to identify the individual components of foods that may cause allergies and to remove them from food, or change them, so that the food can be consumed safely. A number of commercial products derived through genetic engineering have been approved through regulatory processes that address environmental and food safety concerns. These products are available, or will shortly be available, to growers, producers, and consumers. They will provide foods and feeds that are produced with fewer chemical inputs and have improved nutritional composition and quality.

Keywords: Biotechnology, Food quality, Genetic engineering, Quality improvement, Transgenics.

Ajay Kumar Tomer¹, Kuldeep Tyagi and Jai Prakash Lal. (Department of Genetics and Plant Breeding, I. Ag. Sc., B.H.U., Varanasi 221 005 ¹Division of Genetics, Indian Agricultural Research Institute, New Delhi 10 012). Selection of promise drought

tolerant mutant lines in lentil (*Lens culinaris* Medik.) *Indian J. Genet.*, 67 (2) (2007): 140 – 144.

Four lentil varieties of small seeded group (PL-639 and PL-406) and bold seeded group (K-75 and L-4076) mutagenised through gamma rays (10, 20 and 30 kR), EMS (0.04 M), sodium azide (0.05 M) and their combinations were evaluated for induced genetic variability and to identify the drought tolerant mutant lines and the trait(s) responsible for enhancing grain yield under rainfed condition. The findings suggest that materials ought to be tested in both moisture stress and moisture non-stress conditions so that the favourable alleles under drought can be maintained as well as the selection response under favourable condition can be maximized. Yield under drought (Y_d), yield potential (Y_p), drought susceptibility index (S) and geometric mean (GM) were considered as the potential indicators for assessing drought resistance of a mutant line. Correlation coefficients between these parameters revealed that GM was positively and significant correlated with both Y_d and Y_p . There was significant but negative correlation between S and Y_d , while no significant correlation between S and Y_p was observed. It was very clear from the correlation studies that for the enhancement of yield potential under both the conditions selection should be based on GM rather than on S, because S is a better measure of drought tolerance than a measure of performance under stress. Further, selected mutant lines were evaluated for different physiological parameters (nitrate reductase activity, was content and protein content) in M_4 generation and most of them showed higher values for NR activity and wax content. NR activity and wax content may be used as the more reliable parameters to form the basis for selection under rainfed conditions.

Keywords: Induced mutations, drought tolerance, drought susceptability index, NR activity and lentil.

T. Vanaja¹, G. J. Randhawa², R. Singh² and T. Mohapatra³. (¹Pepper Research Station, Kerala Agricultural University, Kanhirankad P.O., Kannur 670 142, ²National Res. Centre for DNA Fingerprinting, National Bureau of Plant Genetic Resources, New Delhi 110 012, ³National Research Centre for Plant Biotechnology, Indian agricultural Research Institute, New Delhi 110 012). **Analysis of molecular diversity and differentiation of photoperiod sensitive and insensitive rice varieties. *Indian J. Genet.*, 67 (2) (2007): 128 – 134.**

A study was undertaken to differentiate photoperiod sensitive and photoperiod insensitive rice varieties and to identify putative RAPD marker (s) associated with the trait. The genetic diversity analysis among photoperiod sensitive and photoperiod insensitive rice varieties using different DNA amplicons, grouped 40 varieties into two major clusters and nine sub-clusters. Sixty five per cent of photo sensitive varieties and 60% photo insensitive varieties were grouped in distinct clusters. The result indicated that response to photoperiod had played a major role in the pattern of clustering. The most distant pairs of rice varieties revealed from genetic distance are Bhagya and Ptb 12, Bhagya and Ptb 7, Sagara and Bhagya, and Dhanya and Bhagya. These distant varieties can be utilized in future breeding programmes as parents to get promising recombinants.

Keywords: Rice, photoperiod sensitivity, molecular markers, RAPD, Jaccard's similarity index, cluster analysis.

G. Padmavathi, N.V. Krishnaiah, G.S.V. Prasad and Y. Kondala Rao. (Directorate of Rice Research Rajendra Nagar, Hyderabad 500 030). Identification of green leafhopper

[*Nephotettix virescens* (Distant.)] resistance genes in rice. *Indian J. Genet.*, **67** (2) (2007): 118 – 120.

The genetics of resistance to green leafhopper, [*Nephotettix virescens* (Distant.)] was studied in four pre-release green leafhopper resistant rice varieties viz., IET 12356 (RP 2432 – 98 – 6 – 3), IET 13268 (HKR 91-102), IET 15359 (BPT 6858), IET 15120 (CRM 47). The parental lines, F₁s and F₂ populations derived from the crosses of resistant varieties with the susceptible variety, TN1 or Phalguna or Sona and inter crosses among resistant varieties were screened against Indian population of green leafhopper in greenhouse at Directorate of Rice Research, Hyderabad. The inheritance of resistance suggested that two dominant complementary genes governed resistance in IET 13268, a single recessive gene in IET 15359, two recessive genes in IET 15120 and a single dominant gene in IET 12356. The single dominant gene of IET 12356 was allelic to Glh 6 in IR 64.

Keywords: Rice, insects, green leafhopper, resistance genes, inheritance, allele tests.

Bioenergy

Byung Hong Kim^{1, 2}, In Seop Chang^{3, 4} and Geoffrey M. Gadd⁵. (¹Korea Institute of Science and Technology, 39-1 Hawolgok-dong, Sungbuk-gu, Seoul, 136-791, South Korea, ²Muri Research Team, University of Southern California, Los Angeles, CA 90089, USA, ³Department of Environmental Science & Engineering, Gwangju Institute of Science and Technology, 1 Oryong-dong, Buk-gu, Gwangju, 500-712, South Korea, ⁴Research Center for Biomolecular Nanotechnology, Gwangju Institute of Science and Technology, 1 Oryong-dong, Buk-gu, Gwangju, 500-712, South Korea, ⁵Division of Environmental and Applied Biology, College of Life Sciences, University of Dundee, Dundee, DD1 4HN Scotland, UK. **Byung Hong Kim (Corresponding author), Email: bhkim@kist.re.kr. Challenges in microbial fuel cell development and operation. *Applied Microbiology and Biotechnology*, Volume 76(3) (2007): 485-494**

A microbial fuel cell (MFC) is a device that converts chemical energy into electricity through the catalytic activities of microorganisms. Although there is great potential of MFCs as an alternative energy source, novel wastewater treatment process, and biosensor for oxygen and pollutants, extensive optimization is required to exploit the maximum microbial potential. In this article, the main limiting factors of MFC operation are identified and suggestions are made to improve performance.

Keywords: Microbial fuel cell - Bioenergy - Renewable energy

S. Chongkhong^a, C. Tongurai^a, P. Chetpattananondh^a and C. Bunyakan^a. (^aDepartment of Chemical Engineering, Faculty of Engineering, Prince of Songkla University, HatYai, Songkhla 90112, Thailand. Corresponding author. Tel.: +66 74287055; fax: +66 74212896). **Biodiesel production by esterification of palm fatty acid distillate. *Biomass and Bioenergy*, Volume 31(8) (2007): 563-568**

Production of fatty acid methyl ester (FAME) from palm fatty acid distillate (PFAD) having high free fatty acids (FFA) was investigated in this work. Batch esterifications of PFAD were carried out to study the influence of: including reaction temperatures of 70–100 °C, molar ratios

of methanol to PFAD of 0.4:1–12:1, quantity of catalysts of 0–5.502% (wt of sulfuric acid/wt of PFAD) and reaction times of 15–240 min. The optimum condition for the continuous esterification process (CSTR) was molar ratio of methanol to PFAD at 8:1 with 1.834 wt% of H₂SO₄ at 70 °C under its own pressure with a retention time of 60 min. The amount of FFA was reduced from 93 wt% to less than 2 wt% at the end of the esterification process. The FAME was purified by neutralization with 3 M sodium hydroxide in water solution at a reaction temperature of 80 °C for 15 min followed by transesterification process with 0.396 M sodium hydroxide in methanol solution at a reaction temperature of 65 °C for 15 min. The final FAME product met with the Thai biodiesel quality standard, and ASTM D6751-02.

Keywords: Oleic acid; Palmitic acid; Taguchi method; Biodiesel

Alok Kumar Tiwari^a, Akhilesh Kumar^a and Hifjur Raheman^a. (^aAgricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur 721302, India. Corresponding author. Tel.: +91 3222 283160; fax: +91 3222 282244). Biodiesel production from jatropha oil (*Jatropha curcas*) with high free fatty acids: An optimized process. *Biomass and Bioenergy*, Volume 31(8) (2007): 569-575

Response surface methodology (RSM) based on central composite rotatable design (CCRD) was used to optimize the three important reaction variables—methanol quantity (M), acid concentration (C) and reaction time (T) for reduction of free fatty acid (FFA) content of the oil to around 1% as compared to methanol quantity (M') and reaction time (T') and for carrying out transesterification of the pretreated oil. Using RSM, quadratic polynomial equations were obtained for predicting acid value and transesterification. Verification experiments confirmed the validity of both the predicted models. The optimum combination for reducing the FFA of *Jatropha curcas* oil from 14% to less than 1% was found to be 1.43% v/v H₂SO₄ acid catalyst, 0.28 v/v methanol-to-oil ratio and 88-min reaction time at a reaction temperature of 60 °C as compared to 0.16 v/v methanol-to-pretreated oil ratio and 24 min of reaction time at a reaction temperature of 60 °C for producing biodiesel. This process gave an average yield of biodiesel more than 99%. The fuel properties of jatropha biodiesel so obtained were found to be comparable to those of diesel and confirming to the American and European standards.

Keywords: Optimization; CCRD; RSM; Free fatty acid; Pretreatment; Transesterification

Alain A Vertès^{1 2 *}, Masayuki Inui², Hideaki Yukawa². (¹London Business School, UK, ²Research Institute of Innovative Technology for the Earth, Kyoto, Japan. *Correspondence to Alain A Vertès, Sloan Fellowship, London Business School, Regent's Park, London NW1 4SA, UK, email: Alain A Vertès (mmg-lab@rite.or.jp). Alternative technologies for biotechnological fuel ethanol manufacturing. *Journal of Chemical Technology & Biotechnology*, Volume 82(8) (2007): 693 - 697

The challenges of implementing biorefineries on a global scale include socioeconomic, financial, and technological constraints. In particular, the development of biorefineries is tightly linked to the continued availability of fermentation raw materials. These constraints can be relaxed by the use of diverse raw materials, while advances that confer higher flexibility would enable biotechnological plant managers to swiftly react to volatile markets. In conventional processes, *Saccharomyces cerevisiae* grows on a relatively limited range of substrates, and produces only a single product - ethanol. Given the observed maturity of the *S. cerevisiae* fermentation technology, alternatives to baker's yeast may be needed to tip the economic balance in favour of

biotechnological ethanol. These alternative fermentation technologies may allow a greater diversity of substrates to be used to produce an individually tailored mix of ethanol and other chemicals. Copyright © 2007 Society of Chemical Industry

Keywords: commodity chemical • white biotechnology • disruptive technology • biorefinery • bioethanol • *Saccharomyces cerevisiae* • multiplex fermentation process • genetic modification • separation technologies **Claudio Muñoz^{1,2}, Regis Mendonça^{1,2}, Jaime Baeza^{1,3}, Alex Berlin⁴, John Saddler⁴, Juanita Freer^{1,3,*}.** (¹Renewable Resources Laboratory, Biotechnology Center, Universidad de Concepción, Casilla 160-C, Concepción, Chile, ²Faculty of Forest Sciences, Universidad de Concepción, Casilla 160-C, Concepción, Chile, ³Faculty of Chemical Sciences, Universidad de Concepción, Casilla 160-C, Concepción, Chile, ⁴Forest Products Biotechnology, Faculty of Forestry, University of British Columbia, Vancouver, BC V6T 1Z4, Canada. *Correspondence to Juanita Freer, Universidad de Concepción, Casilla 160-C, Concepción, Chile, email: Juanita Freer (jfreer@udec.cl). **Bioethanol production from bio-organosolv pulps of *Pinus radiata* and *Acacia dealbata* Journal of Chemical Technology & Biotechnology, Volume 82(8) (2007): 767 - 774**

Wood chips from *Pinus radiata* and *Acacia dealbata* were pretreated with the white-rot fungi *Ceriporiopsis subvermispora* and *Ganoderma australe*, respectively, for 30 days at 27 °C and 55% relative humidity, followed by an organosolv delignification with 60% ethanol solution at 200 °C for 1 h to produce pulps with high cellulose and low lignin content. Biotreatment for 30 days was chosen based on low weight and cellulose losses (lower than 4%) and lignin degradation higher than 9%. After organosolv delignification, pulp yield for *P. radiata* and *A. dealbata* pulps was 45-49% and 31-51%, respectively. *P. radiata* bio-pulps showed higher glucan (93%) and lower lignin content (6%) than control pulps (82% glucan and 13% lignin). *A. dealbata* bio-pulps also showed higher glucan (95%) and lower lignin content (2%) than control pulps (92% glucan and 4% lignin). Pulp suspensions at 2% consistency were submitted either to separate enzymatic hydrolysis and fermentation (SHF) or simultaneous enzymatic saccharification and fermentation (SSF) for bioethanol production. The yeast *Saccharomyces cerevisiae* was used for fermentation. Glucan-to-glucose conversion in the enzymatic hydrolysis of control and bio-pulps of *P. radiata* was 55% and 100%, respectively, and it was 100% for all pulp samples case of *A. dealbata*. The highest ethanol yield (calculated as percentage of theoretical yield) during SHF of *P. radiata* control and bio-pulps was 38% and 55%, respectively, and for *A. dealbata* control and bio-pulps 62% and 69%, respectively. The SSF of *P. radiata* control and bio-pulps yielded 10% and 65% of ethanol, respectively, and 77% and 82% for *A. dealbata* control and bio-pulps, respectively. In wood basis, the maximum conversion obtained (g ethanol per kg wood) in SHF was 37% and 51% (for *P. radiata* and *A. dealbata* pulps, respectively) and 44% and 65% in SSF (for *P. radiata* and *A. dealbata* pulps, respectively) regarding the theoretical yield. The low wood-to-ethanol conversion was associated with low pulp yield (*A. dealbata* pulps), high residual lignin amount (*P. radiata* pulps) and the low pulp consistency (2%) used for SHF and SSF.

Keywords: bioethanol • organosolv pulping • *Pinus radiata* • *Acacia dealbata* • *Ceriporiopsis subvermispora* • *Ganoderma australe*

Bo Liu, Zongbao (Kent) Zhao^{*}. (Division of Biotechnology, Dalian Institute of Chemical Physics, CAS, Dalian 116023, China. *Correspondence to Zongbao (Kent) Zhao, Division of Biotechnology, Dalian Institute of Chemical Physics, CAS, Dalian 116 023, China. email: Zongbao (Kent) Zhao (zhaozb@dicp.ac.cn). **Biodiesel production by direct methanolysis of**

oleaginous microbial biomass. Journal of Chemical Technology & Biotechnology, Volume 82(8) (2007): 775 – 780

Biodiesel is a renewable fuel conventionally prepared by transesterification of pre-extracted vegetable oils and animal fats of all resources with methanol, catalyzed by strong acids or bases. This paper reports on a novel biodiesel production method that features acid-promoted direct methanolysis of cellular biomass of oleaginous yeasts and filamentous fungi. The process was optimized for tuning operation parameters, such as methanol dosage, catalyst concentration, reaction temperature and time. Up to 98% yield was reached with reaction conditions of 70 °C, under ambient pressure for 20 h and a dried biomass to methanol ratio 1:20 (w/v) catalyzed by either 0.2 mol L⁻¹ H₂SO₄ or 0.4 mol L⁻¹ HCl. Cetane numbers for these products were estimated to range from 56 to 59. This integrated method is thus effective and technically attractive, as dried microbial biomass as feedstocks omits otherwise tedious and time-consuming oil extraction processes.

Keywords: biodiesel • oleaginous yeast • microbial oil • methanolysis • fatty acid methyl esters (FAME)

Carlos A. Cardona^a and **Óscar J. Sánchez^{a, b}**. (^aDepartment of Chemical Engineering, National University of Colombia at Manizales, Cra. 27 No. 64-60 Of. F-505, Manizales, Caldas, Colombia, ^bDepartment of Engineering, University of Caldas, Calle 65 No. 26-10, Manizales, Caldas, Colombia. Corresponding author. Tel.: +57 6 8810000x50417; fax: +57 6 8810000x50193). **Fuel ethanol production: Process design trends and integration opportunities. Bioresource Technology, Volume 98(1) (2007): 2415-2457**

Current fuel ethanol research and development deals with process engineering trends for improving biotechnological production of ethanol. In this work, the key role that process design plays during the development of cost-effective technologies is recognized through the analysis of major trends in process synthesis, modeling, simulation and optimization related to ethanol production. Main directions in techno-economical evaluation of fuel ethanol processes are described as well as some prospecting configurations. The most promising alternatives for compensating ethanol production costs by the generation of valuable co-products are analyzed. Opportunities for integration of fuel ethanol production processes and their implications are underlined. Main ways of process intensification through reaction–reaction, reaction–separation and separation–separation processes are analyzed in the case of bioethanol production. Some examples of energy integration during ethanol production are also highlighted. Finally, some concluding considerations on current and future research tendencies in fuel ethanol production regarding process design and integration are presented.

Keywords: Fuel ethanol; Process design; Process synthesis; Process integration; Co-products

Wei Li^a, Wei Du^a and Dehua Liu^a . (^aDepartment of Chemical Engineering, Tsinghua University, Beijing 100084, China Corresponding authors. Fax: +86 10 62785475). *Rhizopus oryzae* IFO 4697 whole cell catalyzed methanolysis of crude and acidified rapeseed oils for biodiesel production in *tert*-butanol system. *Process Biochemistry*, Volume 42(11) (2007): 1481-1485

Whole cell *Rhizopus oryzae* (*R. oryzae*) IFO4697 immobilized within biomass support particles (BSPs) was used as catalyst for biodiesel production in *tert*-butanol, in which the stability of the catalyst could be enhanced significantly. Different feedstocks (refined, crude and acidified rapeseed oils) were adopted further for biodiesel production in *tert*-butanol system and it was found that when acidified rapeseed oil was used as feedstocks, the reaction rate and final methyl ester (ME) yield were significantly higher than that of refined and crude rapeseed oil. Major differences among the aforementioned oils were found to be the contents of free fatty acid (FFA), water and phospholipids, which showed varied influences on whole cell mediated methanolysis for biodiesel production. The reaction rate increased with the increase of free fatty acid content in oils; water content had varied influence on reaction rate and biodiesel yield; using adsorbent to remove excessive water could increase biodiesel yield significantly (from 73 to 84%); it was also found interestingly that phospholipids contained in oils could increase the reaction rate to a certain extent.

Keywords: Biodiesel; Free fatty acids; Crude and acidified rapeseed oils; Whole cell; Methanolysis; *Tert*-butanol

Name of Journals

1. Acta Biotechnologica
2. Aerobiologia
3. Annual Review-Plant Pathology
4. Annual Review- Ecology and Systematics
5. Annual Review-Biochemistry
6. Annual Review-Biomedical Engineering
7. Annual Review-Biophysics and Biomolecular Structure
8. Annual Review-Microbiology
9. Annual Review-Pharmacology and Toxicology
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